THE COVERAGE PROBLEM OF THE INJURED EXTREMITY

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S HOULD the mangled, denuded hand, or the dirty, lacerated, crushed foot be amputated or saved? Neat judgment must be exercised as the decision concerns the life and future usefulness of the individual. Most men still make their living by the use of their hands, and get about by walking on their feet. It is easy to throw away something but it is impossible to create tissue. We can only substitute for losses. The salvage of all useful tissue is then fundamental and must be foremost in the mind of the surgeon. The possibilities of reconstruction should be considered from the beginning and not be dismissed with the thought that someone else can make the injured limb useful again.

How should the open wound be covered? Will skin alone suffice or should a skin, fat, and fascial covering be added? In general, the simplest method to give a good functional result is the best method. Healing should take place from the outside in as well as the inside out.[2] Slow surface healing can result only in a thick contracting scar covered by thin, poorly attached, scar epithelium which is easily knocked off, reopening the wound to infection, causing further scarring and contracture, and exposing, perhaps, some vital structure to permanent damage. Complete, rapid healing, should then be striven for to avoid the complications of the wound left long open.[15] This is particularly true in the hand wherein there are many delicate mechanisms which can be permanently crippled by fibrosis.[5-11] If these structures are sufficiently covered by a sub-

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cutaneous pad, a free skin graft will give a good result. If tendons, nerves, bones, or joints are exposed, more than skin is needed for protection and function; therefore, a graft of skin with subcutaneous pad must be used to cover. The blood supply of this added cover must be its own until such time as a new blood supply can be formed in the union of the graft and the recipient site. A pedicled graft (flap) is then needed, either from adjacent tissue or from a distance.

The technic of executing the successful transfer of tissue for coverage is not very difficult if the planning is correct and fundamental principles are followed. The flap must be planned so as to have a good blood supply and should be placed on a base which has good vascularization.[2-3-4] It should not be made to cover any nonviable structures. Immobilization during the healing period should be complete, and pressure should be applied over the flap to avoid venous and lymphatic stasis and to avoid the collection of blood or serum beneath the flap.[1] The base should not be sectioned until the new blood supply is well established. The base of the flap should be as wide as possible and should not be kinked, twisted, or pressed against sufficiently to impede the flow of blood.

THE UPPER EXTREMITY

A skin graft should be utilized when it will give sufficient coverage. When a pedicled graft is needed the donor site of the flap is generally the abdomen or antero-lateral chest wall. Local flaps are generally not obtainable without uncovering important structures. A palmar flap is possible but it is difficult to maintain in fixation to the finger tip, and scars the good palm. The volar forearm or medial upper arm can be used as a crossed arm flap,[7] but this procedure ties up both arms at once and requires nursing assistance for the patient who can do nothing for himself. A small wide based flap of skin and subcutaneous fat raised from the surface of the abdomen or chest wall is the most useful procedure. If possible, a non-hair bearing area of skin should be selected. Usually general anesthesia is needed, but, if small, the flap can be raised and applied under local anesthesia. Adrenalin should never be used in the novocaine for this procedure. The arm and hand can be held in a position of comfort when the opposite side of the abdomen or chest wall is used for the donor site. The base of the flap if wide enough can be made in any direction but, in general, the base should be perpendicular to the blood supply of the region to allow the most number of blood vessels to enter the flap.[17] The base may be superior or inferiorly placed on the abdomen. If the flap is of any appreciable size it should be the thickness of the abdominal wall because most

of the major vessels run along the layer of deep fascia.[19] A thick panniculus may be troublesome when large flaps are needed. The donor area of the flap (for all small flaps) can be closed. A few interrupted fine catgut or nonabsorbable sutures close the subcutaneous tissues, and the skin edges can be approximated by fine interrupted silk without tension. The applied flap is sutured so as to produce a nearly closed wound. If complete closure is desirable, the free open under surface of the base of the flap can be covered by a split skin graft cut from anywhere, or the base, if long enough, can be tubed[17] producing a single open ended tube. This is a very satisfactory procedure. If closure by suture of the donor bed of the flap is impossible because of tension, a split skin graft should cover the wound.

Fixation of the arm, forearm and hand must be fairly complete to the chest wall. Adhesive tape or elastoplast applied in large amounts is quite adequate but the skin should be protected by a coating of ace adherent or compound tincture of Benzoin. In small children, due to their lack of cooperation, fixation must be more sure. Pressure should be maintained over the flap, but it is desirable to leave a tape free window over the flap so that it can be inspected easily without disturbing the fixation of the arm. To make sure that the base is not kinked or pressed against by position of the arms, the flap should be inspected after the patient returns to the ward again in four hours, and two or three times the following day. If the patient is allowed out of bed or to sit up, the position should again be inspected, as the change in posture may put the base of the flap on a stretch or under pressure.

Section of the base of the flap is done after the blood supply is sufficiently established. This requires on the average of from 14 to 21 days. If the base is wide and the attachment is of small area, the base should be sectioned in stages, cutting first one-half or less of the base under local anesthesia and resuturing the incisions. Three or four days later the base may be sectioned fully or again partially, depending upon the judgment of the surgeon in regard to the establishment of the new blood supply. After final severance of the base of the flap, usually at this time no effort is made to suture down the free margins because of the operative danger to the revascularized tissues. If the open wound of the cut base on the abdomen or of the cut end of the flap is dirty or a bit blue, continuous wet dressings of saline without heat should be applied, and changed daily for a few days. Revision and closure can be done when the operator is sure that the new blood supply is adequate and closed infection is unlikely.

A final revision is often necessary a few months after healing has taken place to smooth the humped juncture of the flap to the recipient wound margins or to remove excessive fat in the flap. The defatting procedure, if the flap is too large, cannot be done in one stage because to do so would cut off the blood supply of the undermined flap.
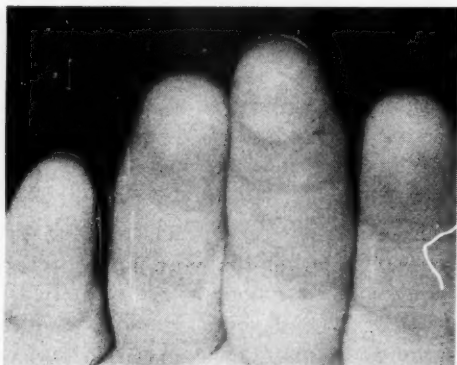

Fig. 1.   Full thickness skin graft on tip of middle finger after six months. Full usage, no disability.

Open direct flaps may become somewhat foul after several days. A change of the dressings may be indicated after a week or ten days for general cleanliness, for the avoidance of excoriation and maceration of the surrounding skin, and for the comfort of the patient and his neighbor patients on the ward. The odor can be nullified somewhat by pouring a few c.c. of Balsam of Peru or other suitable non-irritating aromatic liquid over the exposed granulating areas. An abdominal pad in the axilla, and between the touching parts of the arm or forearm and body wall, will avoid maceration, skin irritation, and pressure points.

Finger Tip. A common injury is the sliced or torn off finger tip. Should this wound be allowed to heal by itself, the finger is not usable for three or four weeks and the resultant scarred tip will be painful and not very serviceable. Partial amputation, sacrificing length to obtain good primary closure, is not necessary. A full thickness skin graft can be sutured to the wound margins if a good viable pulp is present, and the take is almost always perfect. Healing is rapid and the finger is useful within 2 or 3 weeks. Although palmar and plantar skin is a special organ, the substitution of skin with a good dermal pad will produce a good finger tip with good sensation in about three months. The graft can be taken under local

anesthesia from any area, but usually the volar forearm or medial upper arm will supply a non-hair bearing skin within the same operative field, making the preparation and draping easier. All dead pulp should be removed but any debridement of the hand should be conservative. The digital nerves can be blocked easily at the finger base or metacarpal head level. Novocaine (2 per cent) without epinephrine is quite a satisfactory anesthetic agent. The graft can be cut to pattern, but an estimated size, usually being 1.5 to 2 cm. in diameter, is satisfactory. Fine interrupted silk sutured under slight tension gives local fixation to the wound edges but a snug pressure dressing should be applied over the finger tip. The first dressing at six or seven days will reveal slight loss of the epidermis, which peels off readily, but the graft beneath will be pink and in good condition. Daily dressings for a few days using nearly dry, vaseline, fine meshed gauze are necessary. A full thickness graft is susceptible to infection and demands more meticulous care than a split graft. The final result is nearly as good as the original finger tip and certainly is better than the shortened amputated finger end[14] (fig. 1).

Should the terminal phalanx be exposed, a different decision will have to be made. The finger tip can be amputated with volar flap closure, but, again, length is desirable. If only a small amount of bone is bared it can be rongeured conservatively and a full thickness graft applied as before described. The pulp in this case must fall in from the sides so that a subcutaneous pad covers the bone before the graft can be sutured. Skin adherent to bone is not a satisfactory finger tip even though the graft takes. Exposure of bone over three or four mm. in size usually necessitates revision of the tip or flap coverage to conserve length and useful function.

Fingers. The direct open tube pedicle from the abdomen[17] is very useful for the coverage of denuded finger and for adding length to the amputated finger stump, particularly when a bone graft will be needed later for stability and length. The "degloved finger" often has the bones and tendons intact but must have flap coverage. It is easy to amputate such a finger (fig. 2A) ; in fact, such is the frequent procedure employed when such a badly injured finger is first seen. The finger, avulsed of its soft tissue covering, can be inserted into the open end of the abdominal tubed pedicle, and sutured with ease to make a closed wound. Revision, defatting, and, if necessary, bone grafts for length, will produce a very useful finger well worth saving (fig. 2B). Nerve supply returns slowly, and is never complete, but is usually sufficient to allow the patient to protect his finger. Pain, heat, and touch sensations return in varying degrees after several months. Should no sensation return, the procedure

would not be worth while, as an anesthetic finger is often worse than useless. Such a covered degloved finger frequently does not develop good reflex vascularization and will be cold and blue in cold weather. Non-constricting warm gloves or mittens should be worn. Protection of the flap from harm during its anesthetic period is important. Too much pressure can cause loss of surface and indolent ulceration.
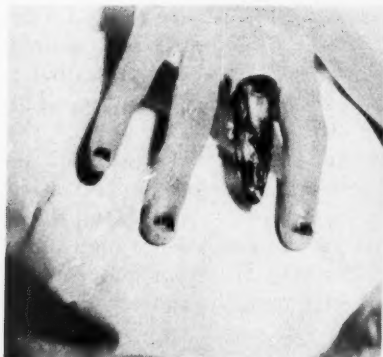

Fig. 2-A   Fig. 2-B

Fig. 2-C

Fig. 2. A. Degloved middle finger four hours after coveraging torn off by a ring the girl was wearing. Distal two-thirds of distal phalanx avulsed but tendons intact. B. Immediate coverage effected by inserting bared finger in open end of abdominal flap tubed. Donor site closed. C. Finger six weeks after section of the pedicle base. The flap will be defatted and a bone graft added.

Hand. Denuded portions of the hand can be managed in the same manner as described for the finger. The ideal time for coverage is at the time of injury. Loss of skin only, except for burns which are somewhat different in that the depth of skin damage is so difficult
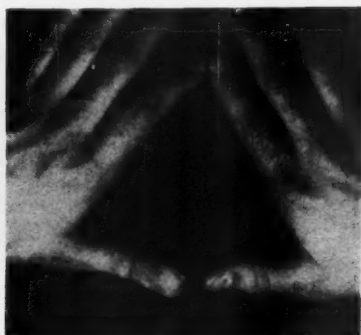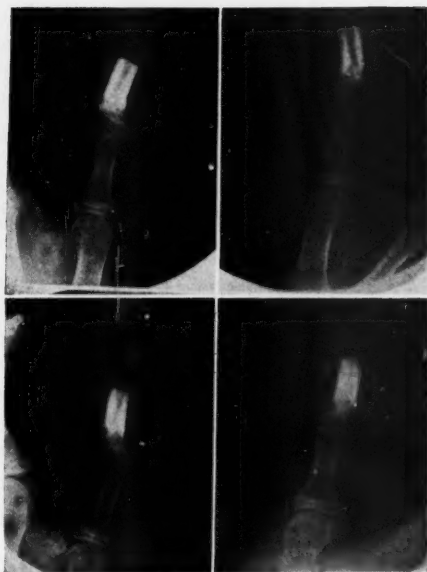
Fig. 3-A

Fig. 3-B

Fig. 3-C

Fig. 3. A. Loss of distal half of thumb one month after injury. Base of distal phalanx present. B. Reconstructed distal end of thumb one year after injury. An open tubed abdominal pedicle added soft tissue length. A piece of a 5th metatarsal (bone bank) was grafted to the stump end of the distal phalanx. Two revisions of the flap have been made. C. Serial x-ray photographs over five months time showing union of bone graft (5th metatarsal from bone bank) to stump of distal phalanx.

to determine at the time of injury, should be treated by an immediate thick split graft applied after cleansing and conservative debridement. It should go without saying that the cleansing process should consist of only bland soap and water followed by generous flushing with normal saline. None of the surgical antiseptics should be used as nearly all of them are of such strength as to damage the open tissues. The skin graft should be dressed initially after 5 to 7 days.

With deeper losses of tissue, exposing tendons, nerves, bones or joints, flap coverage is necessary. Since local flaps are not available, except for small wounds where a skin graft can cover the donor flap site without exposing other important structures, a distant donor source for the flap is needed. The thoracoabdominal wall is again the most useful region. Wide based open flaps are readily available and most useful. Bipedicled open or pocket type flaps may be needed if the width needed is too narrow for the length of the flap (fig. 4C). The length of this flap should not exceed three times the width for safety, but a ratio of 2 to 1 or less is safer (fig. 4D). Occasionally the base of this flap can be tubed to close the wound, but, if closure is desired, a skin graft on the open under surface is a safer procedure, as it does not jeopardize the blood supply. A bipedicled tube graft[10] is not needed or desirable for coverage of this type of injury. Denuded forearms or upper arms, with exposure of important structures, can be covered by using large wide based apron type flaps.[4]

Associated local injuries may produce problems. Compound fractures with displacement are often present. If alignment cannot be maintained, it is preferable to give coverage the priority, as the well vascularized flap is an ideal operative site for reconstructive bone surgery later; whereas, a skin graft or scar epithelium is not a satisfactory coverage because both will not heal well. Lacerated tendons without good coverage, especially if the wound can be made only relatively clean without too extensive a debridement, had best be left untouched. A secondary tendon repair or tendon graft in the soft supple fat of the added flap, gives a better result than attempted primary repair in these dirty wounds, and is often a few hours old at the time received for treatment. Open joint cavities should be meticulously cleansed and closed before flap coverage is applied. Severed nerves may be repaired primarily with fine silk or wire, if there is no loss of substance, or if the wound is clean and not more than a few hours old, but, again, secondary nerve suture within four to eight weeks is much better, if there is an appreciable danger from infection. It must be remembered that the open under surface of an open flap is an open wound and, therefore, invariably
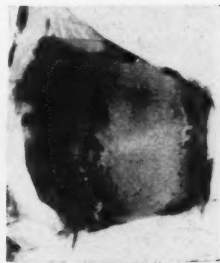
| Fig. 4-A | Fig. 4-B | Fig. 4-C |

Fig. 4. A. Coveraging of the back of the hand avulsed in automobile accident—six hours after injury. B. After cleansing debridement. C. One week after suture of the hand under a pedicled abdominal flap with split skin graft applied to the donor bed.
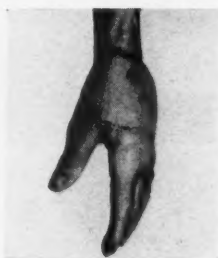

| Fig. 4-D | Fig. 4-E | Fig. 4-F |

Fig. 4. D. Healed donor site. E. Flap before defatting. F. Very little limitation of flexion, full extension.

infected during the waiting stage of establishing the new blood supply. In order to facilitate finding the nerve ends for secondary suture, a black silk ligature tied around the tip of each end of the cut nerve is useful. The two ligatures may be loosely tied together to prevent contracture and separation of the ends. Digital nerves must not be regarded as being so small as to be inconsequential or too small to work with. The anesthetic finger may be worse to the patient than no finger at all. Digital nerves should be protected, saved, and repaired.

The filleted finger or toe flap[11] is useful coverage for loss of tissue at the base of an adjacent finger or the adjacent palm or dorsum of the hand. Instead of amputating completely the badly damaged finger, viable portions of the skin and subcutaneous tissue, still attached, and with good blood supply, can be used to great advantage. With removal of the bone, the skin and subcutaneous tissue opened out, may give a sizeable flap to cover the denuded palm or back of the hand (fig. 6B).
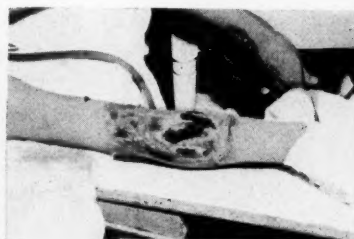
Fig. 5-A1

Fig. 5-A2

Fig. 5-B

Fig. 5-C

Fig. 5-A1 & 2. Elbows one month after severe wringer injury. Brachial artery bleeding necessitated flap coverage before all slough removed. Mixed nerve injury in both forearms and hands. B. Bilateral apron type chest wall flaps immediately after application. Good coverage has been obtained but small additional skin grafts had to be utilized at same time for complete coverage. C. Flaps cover antecubital fossae well. Further skin grafting necessary for contractures.

Burns. Burned skin of the extremities constitutes a special problem not particularly within the scope of this discussion. Immediate coverage offers a difficult problem because of the uncertainty of the depth of the burn when it is first seen and treated. Obvious full thickness losses of the skin should be removed and a graft applied immediately to give the most rapid healing possible, but, so often, the burn is not through the entire skin and satisfactory healing will take place spontaneously. A mixed second and third degree burn may epithelize so slowly that the resultant healing causes much contracture, keloid formation, and secondary fibrosis around tendons and joints with the resultant crippled stiff hand. It is better to sacrifice relatively early the few islands of regenerating epithelium and apply a thick split skin graft. Yet, one cannot be sure of these islands, or the depth, much under ten days or two weeks. As soon as tendons are seen uncovered after removal of the primary vaseline gauze pressure dressing, or during the daily changes of wet dressings, flap coverage is a must. When the flap is applied, the wound should be cleanly granulating and free of slough. The slough should

be removed surgically before or at the time of flap coverage. Tendons exposed will surely slough. If one waits long in the preparation of granulations on paratenon before skin grafting, there will be much fibrosis with a resultant relatively stiff hand. The exposed palmar aponeurosis will slough, when exposed, in the same manner as tendons. Open suppurating joints, after a burn, will surely be ankylosed by bony or fibrous union.

Fig. 6-A   Fig. 6-B

Fig. 6. A. Hand three weeks after burn from steam mangle. Joints open and suppurating. Flap coverage is not indicated because of the expected stiff finger. B. Wound closed by filleting the bones of the finger including most of the 5th metacarpal and using the remaining lateral side of the finger as a flap.

An electrical burn, other than the flash type, may be expected to be deep. Debridement here should be early and more radical, exposed tissues being covered as indicated. Not infrequently these burns extend down to or through bone but tend to be fairly well localized. The difficulty of early debridement and immediate flap closure is a result of the inability of the operator to distinguish the limit of the burn. Flaps or grafts applied over dead tissue cannot survive, or, if the flap can gain attachment from surrounding viable structures, there will be prolonged drainage and infection under flap from the presence of the dead structures until they are extruded or removed.

Wringer Injuries. Wringer injuries constitute the same type of problem. These fairly common wounds are extremely difficult to appraise initially as to their depth and extent (fig. 5). The skin may not be broken but has much the appearance of a third degree burn. The skin appears gray, white or brown, and is often oozing serum, but rapidly forms a tough eschar of dead dried skin over the surface. The subcutaneous fat and fascia have been shaken, crushed, or jarred to such depth as to expose large vessels, tendons, or nerves when the slough is removed. The limits of cellular death are hard to determine. Some conservatism in debridement is necessary to

avoid the removal of good tissue. Daily changes of wet dressings will properly prepare the granulations and remove the slough, but the process may be slow. As soon as nerves, tendons, vessels, bones or joints are bared, they should be covered by a flap, but much more debridement may be necessary to avoid covering the dead tissue with the flap. Injured but intact nerves will probably regenerate. When the skin is broken by the wringer and the subcutaneous tissue is pushed away from muscle fascia there is often an overhanging, loose wound margin, that becomes readherent to the deep fascia slowly because of the presence of some dead fat or fascia in the deepest cleft of the wound. A skin graft may be lost if applied too early before the loose wound edges are stuck down.

LOWER EXTREMITY

The principles of management involved for coverage of surface losses of the lower extremities' injuries are mainly the same as for the upper extremity. Technically, the coverage problem is a bit more difficult for the leg because of its poorer blood supply, and because distant pedicle grafts are more difficult to plan and to maintain in fixation.

Foot. The sole of the foot is an organ designed to stand the pressure of weight bearing.[3] Plantar skin is adapted to receive much pressure and any substitution of tissue for coverage can never be as good. Free skin grafts, on pressure-bearing points such as over the heel or ball of the foot, will not stand up under the wear and tear of daily use; whereas a pedicle graft, after it develops sensation, will. A skin graft applied to the mid-plantar surface under the longitudinal arch or on the under surface of the toes may be satisfactory. The thicker the graft the better the ultimate function but the less the chance of a complete take. A simple scar on the plantar surface may be very debilitating. Grafts are not adequate for coverage of the posterior heel or over the Achilles tendon. A cleanly avulsed wound of the sole should be covered by the split graft to convert the wound into a cleanly closed healed surface. The problem of definitive coverage can be solved later if an immediate flap is not practicable at the time of injury.

The technical problem of flap coverage, for these sites previously mentioned, is more difficult than with the hand. Local flaps are rarely possible without additional undesirable scarring. The blood supply of the foot and leg is much poorer than that of the hand and arm. A readily available distant donor site which can be applied with relative comfort to the patient is not present. The two best flap donor sites are the opposite calf or anterior thigh. This cross leg flap can be performed directly in one stage with a high per-

centage of success,[7,13,16] but the operation is difficult because of blood supply and proper fixation for healing. When in doubt it is much safer to delay the donor flap in at least two stages.[3] Such delay in time allows the inevitable contracture and fibrosis with attendant prolonged temporary or permanent disability; yet, the loss of the flap from the posterior calf, thus destroying the best donor area, may make the delaying procedure a wiser one. The calf may be an objectionable donor site for women.

The direct flap should be based superiorly with the base as wide as possible and the length of the flap the width of the base or less. The upper two-thirds of the calf, only, should be used, as to go lower means poorer blood supply and exposure of the great flexor tendon. The wide base of the flap must have some curvature, a fact which makes turning the free end less usable because of torsion, stretching or pressure. A poorly muscled calf may be so small that this curvature of the base is too great for much use of the free end. Because most of the blood supply runs along the deep layer of fascia, a thick panniculus means poor blood supply for the bulk of tissue necessarily freed and turned. Dissection should be cleanly performed, and should be along, but not through, the muscle fascia.

The delayed flap can be planned with more latitude. It can be longer than its width and can have its base in any direction but the superiorly placed base in the direction of the normal blood supply is safest. Retrograde flaps may be the most useful for proper positioning of the legs but require more care in planning and more delays. A delayed laterally based hinged type of flap may be very useful. A flap totally raised and resutured in its bed is not a delayed flap. Such a flap proving its viability might as well have been attached to the recipient site at the time of raising.

The sine qua non of the cross leg flap is proper fixation in correct position. Application of the cast requires several strong backs and patience. Rarely is adhesive tape or bandage adequate fixation. Casts or shells may be preformed, using plaster or plexi-glass,[12] but the real problem is holding the legs in exact position until immobilization is complete and accurate. After the plaster has set, to take down the cast and start over may be exasperating, but is worth while if the flap is in danger. Edema, at the base of the flap, comes on soon after surgery, and diminishes the blood supply further. A large window over the flap is desirable to allow observation and dressings. The cast should be well padded with sheet wadding and felt applied over possible pressure points.

It should be a general rule to observe the flap within a few hours of operation, again before night, and on the following morning.

Minor changes in the cast, cutting a little plaster which presses against the base, may save the tissue in danger. The value of pressure against the applied portion of the flap is unquestioned[1] and should be maintained at least for several days. Venous stasis thrombosis is the cause of gradual progressive loss of pedicled grafts. Besides pressure, elevation is of value. By means of weights, pulley traction should raise the cast so that the legs are well above the trunk. The patient is more comfortable in this position, his buttocks rest only lightly or scarcely at all against the sheets, and he can raise himself up to use the bedpan much more easily.

The cross leg flap operation is not a closed operation or an aseptic one. It is nearly impossible to keep the wound clean during the application of the cast because of the necessity of constant observation of the flap. Yet, the obvious contamination seems to make little difference. The donor bed of the flap should be covered with a split skin graft. The open under surface of the flap, from the donor leg to the recipient site, may be covered with a skin graft, but this is difficult and not necessary. These open areas granulate and suppurate so that the odor is sometimes offensive in warm weather. During the fly season an occlusive dressing should be maintained. Maggots may appear but their presence seems to be harmful only to the psyche of the patient and nursing staff.

Section of the flap can be performed under local anesthesia without any special disturbance to the patient. We do this with the patient in his bed in his room. Section is started at about 18 days and completed about 21 days later. Although the flap may be cut through all at once, it is often safer to cut in two stages or more if necessary. When the cast is to be removed on final detachment of the flap, it is better to have the cast cut nearly down or completely bivalved before cutting the flap. This order is used because removal of the cast may take some time and the bleeding ends of the cut flap could allow an appreciable blood loss. It is difficult to stop the bleeding until the cast is off and the legs separated. The free cut margins may be sutured down after section, but it is usually better judgment to apply wet dressings for a few days and suture down the margins later. No revision or defatting procedure should be done at the time of sectioning.

It is better to have some excess fat in the graft on the sole (fig. 7C). This fat, apparently much too large, will flatten out when weight bearing is finally allowed. An early revision, cutting off the hump and making the flap flush with the surface, may produce more subsequent pain from the scar of juncture. Real weight bearing should not be permitted for many months when evidence of sensa-
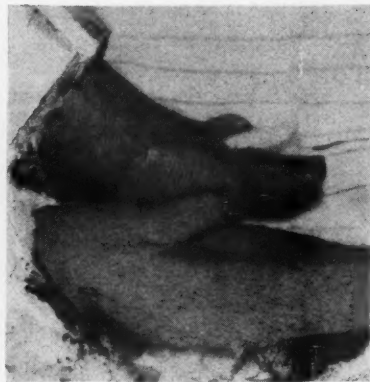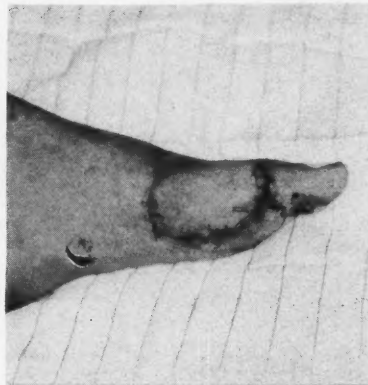
Fig. 7-A

Fig. 7-B

Fig. 7-C

Fig. 7-D

Fig. 7. A. Avulsion over 1st metatarsophalangeal joint, one month after injury. B. Delayed cross leg flap attached at three weeks just before final severance. C. Overhanging margin of attached flap before revision. D. Revised flap just before sutures removed.

tion is returning. This may take 12 months but early the patient can be allowed up on crutches or a walking iron. Care of the graft must be taken the rest of the patient's life. The flap during its anesthetic period must be protected from pressure by an adequate pad of felt or sponge rubber. The skin must be inspected daily and kept dry. With any sign of pressure such as local redness or vesiculation, all weight bearing must be stopped until complete healing takes place. Irreparable damage can be caused in the anesthetic flap without the patient's knowledge.
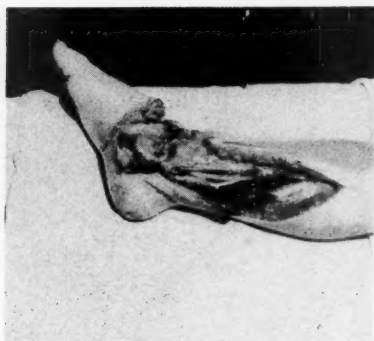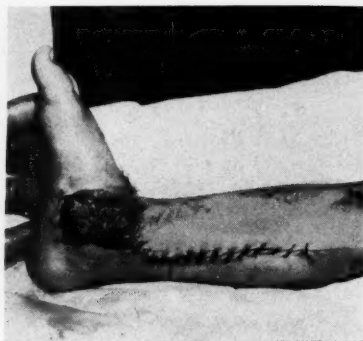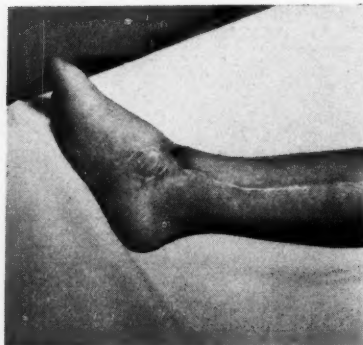
Fig. 8-A

Fig. 8-B

Fig. 8-C

Fig. 8-D

Fig. 8. A. Power mower accident two hours after injury. Girl, aged 4 years. All extensor tendons, posterior tibial and dorsalis pedis arteries, and posterior tibial nerve severed, ankle joint open into three joint spaces. B. After immediate debridement and suture. Joints closed, nerve ends tagged but not definitively repaired, tendons repaired. The remaining surface defect had soft tissue covering over important structures. C. Immediate split graft to denuded surface. D. Good coverage one month after injury. Nerve suture to be done at two or three months.

The Lower Leg. A real and important problem is that of coverage of the exposed tibia.[3-13] Compound fractures of the lower leg commonly damage the thin coveraging over the anterior surface of the tibia so that the loss of tissue exposes the bone directly over the fracture site. *The surgeon may feel compelled to debride the dirty wound or is too forceful in his attempts to close the damaged edematous tissues so that the bone is covered.* Large sloughs (fig. 10A), exposing the bone, invariably produce severe complications which sometimes necessitate ultimate amputations. Any bone uncovered dies in part. Before any coverage can be accomplished this

dead bone must be allowed to sequestrate or be removed before separation. Osteomyelitis, localized, is inevitable, but usually is not extensive. Some cellulitis in the damaged soft tissues may occur following these injuries and must be well controlled with edema subsided before coverage can be attempted. Alignment of the bones by fixation methods may complicate the coverage problem considerably, as the loss of positioning the legs does in the most favorable attitude.

Usually the plastic surgeon is not called in to see the patient for several weeks after the injury. It has been realized that coverage is necessary for healing, for the avoidance of further infection, and for a good operative site through which a bone graft may be inserted for union. First, it may be necessary to clean up the old wound. Boggy excessive granulation tissue would be made red, flat, and relatively dry by daily changes of wet pressure dressings. Scar must be excised as a good vascular base is needed to maintain the nutrition of the covering. If dead bone is present it should be removed. A preliminary saucerizing operation on the bone may be needed to remove sequestra and infected granulation tissue in and around the bone. This procedure is done, of course, by the ortho-

Fig. 9-A   Fig. 9-B

Fig. 9. A. Compound fracture of tibia with bared fracture site one week after injury. Old scar over shin had produced avascular weak bone which broke when patient was lifting a heavy weight. B. Crossed flap by hinged lateral flap delayed. Photograph taken just after suture removal following revision of flap margin at two months—skin grafted donor side on opposite calf.

pedic surgeon. With further pressure wet dressings, the shallow exposed bone cavity will be covered by fine healthy granulations within a few days, so that a thin split graft applied will take completely. An old dirty wound can be converted in a very short time

into a clean healed wound. The skin graft might be permanent, but usually will not stand the trauma of daily life, and, certainly, is an impossible operative field if further bone surgery is needed.

Pedicle graft coverage must be done. The cross leg flap is the

Fig. 10-A
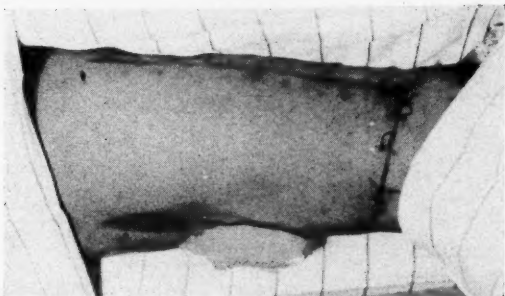
Fig. 10-B

Fig. 10-C

Fig. 10. A. Compound fracture of tibia with bared bone in young woman six weeks after accident. Other leg amputated. B. Anterior surface of leg raised as a bipedicled flap first. Three weeks later the lower end was sectioned in two stages. C. Flap rotated over bone defect and a skin graft applied to the donor bed or rotated flap. All scar from the original injury and all dead and overhanging bone removed at the time of flap placement.

simplest and best solution to the problem. This can be done as described for coverage of the foot. The legs lying together extended are an ideal position for the delayed hinged type of flap (fig. 9B). The base of the flap should be wide and the under surface of the flap should be sutured down to avoid dead space. Within a month or two of completion, operation can be performed through the flap with ease and ultimate good healing. The anterior surface of the thigh may be used at times, especially for defects about the medial malleolus, but the opposite calf is the best donor area.

When defects are quite large or when the opposite leg is also fractured or amputated, coverage must be by local flaps (fig. 10C), or coverage must be brought from a distance. Transfer of a pedicle or bipedicled tube on the opposite or same thigh has been reported successfully accomplished, but such a procedure is difficult and probably not as successful as the open jump pedicles[6] or the closed jump pedicles.[8-18] These latter procedures employ the forearm or wrist as a carrier and use the abdomen or chest wall as a donor site. Open jump flaps appear to be equally as successful as closed flaps and require much less hospitalization.[9]

AMPUTATIONS

A good weight bearing stump of sufficient length is important for the amputee. When length is needed for use of the joint proximal to the amputation, but not enough coverage is present, a flap may be very useful. Skin grafts are indicated after a guillotine type of amputation for simple coverage, but such a graft will not withstand future pressure. The type of pedicle graft applied to the stump must come from a distance, as a local flap must be shifted from another portion of the stump damaging further the weight bearing potential of the skin and fat pad. A cross leg flap from the opposite calf is the quickest means of obtaining good padded coverage, but, if time is not a factor, a bipedicled tube raised from the opposite thigh may be useful or a pedicle may be carried from the trunk on the wrist or forearm as an open or closed jump flap. The anesthetic pedicle must not be allowed to bear weight until its nerve supply develops at least in part.

SUMMARY

1. Early coverage of surface losses of extremities is important for healing without the complications of fibrosis.

2. Skin grafts are satisfactory coverage for simple skin losses but when tendons, nerves, bones or joints are exposed, or when future

reconstructive procedures are contemplated, pedicle grafts with subcutaneous tissue are obligatory.

3. The thoracoabdominal wall is the most satisfactory donor site for upper extremity flap coverage; the opposite calf or anterior thigh are the best donor areas for coverage of leg and foot injuries.

4. Local flaps, rotating or sliding, are quite useful for some surface defects but the donor bed should not be selected from over important structures such as bones or tendons.

5. The finger tip denuded of skin is very satisfactorily covered by a full thickness skin graft.

6. The "degloved" finger can usually be salvaged by implanting the finger in an open ended tubed pedicle. Bone grafts may be added within the flap later if length is desired.

7. The plantar surface is usually best covered by a cross leg flap which must be cared for meticulously until sensation returns.

8. Compound fracture sites over the anterior tibial surface often have to have added coverage by local rotation or cross leg flaps to cover bared bone, to permit union, and to allow future surgery.

9. Amputation stumps, if too short, and inadequately healed for weight bearing, can be covered with a flap to allow future weight bearing.

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SIGMOIDOVESICAL FISTULA

Diagnosis and Recent Advances in Surgical Treatment

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S IGMOIDOVESICAL fistula is one of the more serious complications of diverticulitis, but there is little reference to its treatment in the medical literature of the last eight years. During this period, new remedies and techniques have been made available to the surgeon by the biochemist, and it is essential that the surgical treatment of sigmoidovesical fistula be reassessed in the light of these recent discoveries.

While diverticulitis of the large intestine has been recognized for many years, it has been the subject of relatively few reports. To Dr. William J. Mayo[1] and his associates is credited the first complete clinicopathologic description of the disease, in 1907. Lockhart-Mummery[2] refers to a contribution by Telling of Leeds, in 1908, in which 74 fatal cases were reported.

From these and later publications, information concerning diverticulosis and diverticulitis has accumulated which has diagnostic significance. It is known that a relatively large number of persons beyond middle age, approximately 6 per cent, have diverticulosis of the large bowel, especially in the sigmoid region, and, furthermore, that one in eight of this group will suffer acute diverticulitis causing serious illness and often death. The onset of acute diverticulitis may be so sudden that neither the internist nor the surgeon can interpret the true pathologic basis of the disease, and only at autopsy will it be revealed. The acute form of the disease occurs in men more often than in women, in the ratio of two to one, and is usually confined to persons between 40 and 70 years of age.

The most useful information concerning diverticulosis and diverticulitis as entities has been contributed by the roentgenologists, whose accurate observations have shown that in 90 per cent of cases the diverticula occur in the large intestine. The prominence of the symptoms in the left side of the abdomen has led to such mistaken diagnoses as perinephric abscess, colitis, and carcinoma, and only roentgenologic studies could correct these impressions. In the presence of fistulae, which may communicate with other parts of the lower gastrointestinal tract, the female generative organs, or the bladder, the roentgenologic data is of utmost importance to the

surgeon. There is no other means by which he can determine the source of the fistulous tract before operation.

In diverticulitis, be it congenital, acquired, or a combination of the two, there are one or more areas in the sigmoid in which the
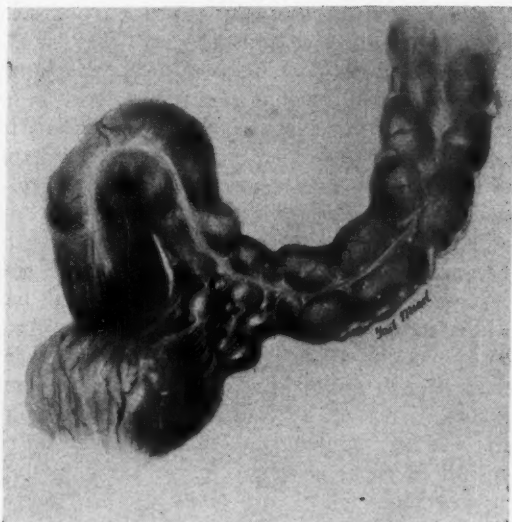

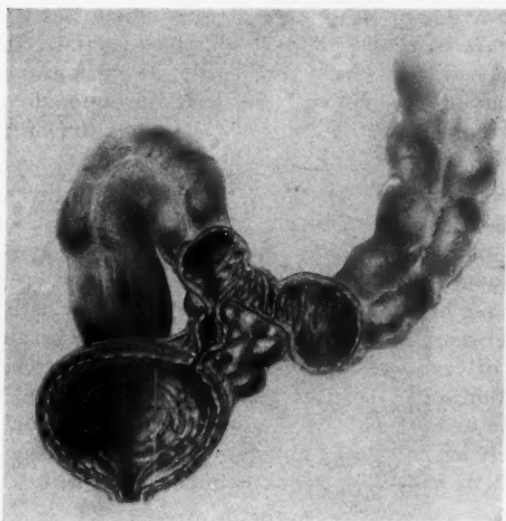Fig. 1. Diverticulitis involving the bladder.

Fig. 2. Cross section of the fistula.

mucous and submucous membranes project through the outer walls
of the bowel, with only thin peritoneum separating the highly infec-
tious intestinal contents from the peritoneal cavity or structures
(bladder, small intestine, or fallopian tube) which may be in contact
with the diverticulum. Should this bubble of peritoneum and mucous
membrane explode from pressure, or rupture from ischemia or in-
fection, only some fortunate circumstance will prevent a devastating
contamination. Should the contents of the diverticulum escape into
the peritoneal cavity, and the condition remain unrecognized for six
or eight hours, only heroic measures will rescue the patient. Should
the bladder be adjacent to the ruptured diverticulum, the inflamma-
tory reaction involved in such a juxtaposition may cause adhesions
to form between the bladder and the sigmoid, with a resulting fistula
(figs. 1 and 2). Neither the diameter nor the length of such a
fistula can be anticipated or modified in its formative stage, but it is
certain that some of the contents of the sigmoid will be discharged
into the bladder, to be followed by cystitis of varying intensity. The
complication is brought to the attention of the physician when the
patient seeks relief from the passage of gas (pneumouria) and
vegetable debris each time he voids, which is annoyingly frequent.
It is true that gas may be generated in the bladder by certain types
of infection, but in such cases it is never accompanied by bits of
tomato skin, vegetable fibers, and other foreign substances, easily
discerned by patient and doctor, and starch cells, fat crystals, and
debris, readily identified microscopically.

The family doctor, who is usually the first to see the patient, is
often unaware of the significance of his complaints, and plies him
with the conventional urinary antiseptics. It is remarkable how long
a patient may tolerate cystitis resulting from sigmoidovesical fistula
without becoming acutely ill, and it may be a matter of many months
before he is referred to a urologist.

In most instances the history of a patient with diverticulitis pre-
ceding sigmoidovesical fistula conforms to type. Mild, left-sided
abdominal pain of variable severity usually has persisted for a
period of months or even years. Constipation and even partial ob-
struction have been noted; blood in the stool has been reported in
10 to 15 per cent of the cases, often leading to the suspicion, or even
diagnosis, of carcinoma of the distal colon or rectum. With such
contamination, one would expect a rapidly ascending infection in-
volving one or both kidneys, but that is the exception and not the
rule. Rarely has an x-ray examination or any extensive survey been
undertaken, or has any specific treatment been instituted.

The attack which ushers in the fistula is usually more severe than
the previous ones; the patient is confined to bed; the temperature is

spiking; lassitude, pain in the left lower quadrant, and the usual anorexia and discomfort which accompany a febrile illness are symptoms. Tenderness is generally noted over the sigmoid with a corresponding area of rigidity; only rarely can a mass be palpated. The acute phase may last from a few days to several weeks, and be
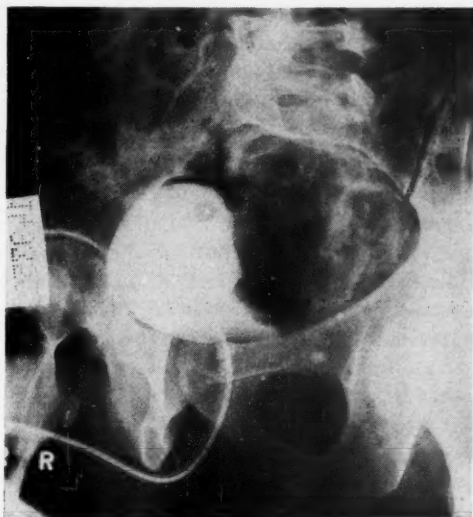

Fig. 3. Arrow indicates sigmoid end of fistula, after barium enema.

Fig. 4. Arrow indicates bladder end of fistula, after cystogram.

followed by a lessening of the abdominal signs and symptoms. The fever continues to fluctuate.

The perforation into the bladder is not announced by aggravation of existing symptoms or any additional symptoms, until cystitis develops. There is no sudden, severe pain with vomiting and mild shock, such as may be observed on perforation of an ulcer. From the inflammatory reaction about the diverticulum, an adhesive exudate has incorporated the contiguous bladder, and it may be deduced from the examination of sigmoid specimens that the fistula is tortuous and narrow, thus allowing the contents of the colon to escape into the bladder in a mere trickle which never becomes a gushing stream.

At first glance one would assume that it would be an easy matter to trace the course of the fistula, but, on the contrary, it is almost impossible. The urologist will inspect the bladder through a cystoscope and find an edematous area near the orifice of the left ureter, but in most cases he is unable to detect the ingress of the contaminant from the sigmoid. The granulating area which may be visualized will more likely be interpreted as an independent lesion. A cystogram may prove useful; for instance in Case 3, the roentgenologist interpreted a small conical projection of the opaque medium as the terminal portion of the fistula, and it was confirmed at operation.

The diagnosis should present no difficulty although the demonstration of the entire fistulous tract is rarely possible. A barium enema will visualize the diverticulosis and may show a projection of the barium from the colon, indicating the origin of the fistula. With a cystogram and barium enema, both ends of the fistula may be demonstrated (figs. 3 and 4).

The nature of the fistula does not lend itself to a clear delineation, but its existence is easily confirmed. An enema of methelyne blue in water was used in one case and blue urine was voided shortly thereafter. It has occurred to me, although I have made no trial of the method, that extract of hematoxylin by mouth should find its way into the bladder in twenty-four hours or less, thus establishing the presence of a sigmoidovesical fistula, as it imparts a bright red color to contents of the bowel.

The history of pain in the left side of the abdomen, with exacerbations, the acute onset, contaminated urine, urologic and roentgenologic examinations can leave little doubt that a fistulous tract exists between the bowel and the bladder. The question of malignant disease naturally arises, as the patients are within the so-called cancer age. Carcinoma of the sigmoid may perforate into the bladder, and

carcinoma may originate a diverticulum, but as the diagnosis can rarely be established in advance, surgical intervention is a matter of necessity and offers the only opportunity for cure, whether the lesion is benign or malignant. There is one contraindication to operation which should always be strictly observed, namely, acute intestinal obstruction. In the presence of such a condition, not only is it impossible to prepare the patient adequately, but the technical difficulties of the operation are almost insurmountable.

Mayo and Miller,[3] in 1940, contributed the last comprehensive analysis of a series of cases in which operation was performed for sigmoidovesical fistula. Before that a number of papers had appeared, but they offered little variation in the surgical treatment, almost all authors recommending some type of colostomy, temporary or permanent, cystotomy, and operation in two or three stages. In 1938, Kellogg[4] did a one stage operation in 12 cases with a mortality of 33.33 per cent, employing a permanent colostomy in most cases.

Cave and Alsop,[5] in 1946, reported 131 patients operated upon for acute diverticulitis between 1934 and 1945 in the Roosevelt Hospital, with a mortality of 15.3 per cent. These included some with sigmoidovesical fistula, but the cases were not segregated. In regard to treatment of fistulae into the bladder, they stated that operation was essential and should include colostomy to divert the fecal stream. They agreed with Dixon[6] that to obtain a cure, a resection of the involved segment of the bowel with the adjacent tract into the bladder must be carried out. Resections of the bladder, in addition to the various types of operations on the colon, were favored by many. The mortality in such procedures ranged from 15 per cent to 30 per cent.

Mayo and Miller reported 88 cases of sigmoidovesical fistulae treated surgically. A tabulation of their results follows:

Cured	35
Fistula cured but fecal fistula remained	7
Improved	5
Unimproved	4
Recurrence	4
Deaths:	
Attributed to primary disease	26
Attributed to unrelated causes	1
Unknown	2
End result unknown	4

The high mortality and unsatisfactory results almost equalled the number of cures. These authors were of the opinion that the mor-

tality from one stage surgical procedures for the correction of fistulæ due to diverticulitis was excessive, and that multiple stage operations were most satisfactory. They recommended colostomy as the first stage, since it obviated spilling from the upper into the lower part of the colon, and they stated that it should be performed as close to the fistula as possible to avoid redundant bowel above the vesico-colonic tract.

The soundness of such conclusions could not be questioned in 1940, but the striking progress in the development of antibiotics has altered profoundly the views on some phases of intestinal surgery, of which repair of sigmoidovesical fistulæ is one. In the past few years, abdominal surgeons have been substituting the single stage for the two and three stage bowel operations, and the so-called aseptic or closed anastomosis has been replaced by the open type, without clamps. These newer techniques have been made possible by the intelligent use of antibiotics. So effective have these drugs been, that infections following bowel resections have been almost eliminated. Poth[7] has demonstrated that sulfasuxadine and sulfathaladine properly given over a prescribed period can render the contents of the bowel practically innocuous. Romansky[8] has asserted that 0.5 Gm. of streptomycin given orally every 6 hours in 8 doses will deprive the contents of their infectious properties. These principles have been applied recently by many surgeons with excellent results, and they now advocate the open type of resection in the bowel.

I have applied this technique to three cases of sigmoidovesical fistulæ, and complete and rapid cure has resulted in each. The reports of these cases are abstracted as follows:

CASE 1. A woman, 54 years of age, was hospitalized May 28, 1947. She had complained of lower abdominal pain for about eight months and was under the care of her family physician. She had had attacks of incomplete intestinal obstruction, and when she was admitted to the hospital, obstruction was almost complete. Roentgenologic examination with barium and air enemas the previous month had shown extensive diverticulitis involving the descending colon. No particular abnormalities were evident in roentgenograms of the urinary tract. At cystoscopic examination on May 17, there was a moderately inflamed, edematous area just above and medial to the left ureteral orifice. No gas or fecal material was observed to come from this area and there were no other abnormalities.

Fecal matter was present in the catheterized specimen of urine, which, upon culture, showed B. coli communis. A methylene blue enema was given and the dye appeared promptly in the urine. The patient had a daily, moderate elevation of temperature. Red blood cells numbered 4,250,000, white blood cells 11,200, and the differential count was normal. No mass could be palpated either upon abdominal or pelvic examinations.

The patient was given fifteen 0.5 Gm. sulfathaladine tablets daily, in

divided doses, beginning five days before the date set for the operation. Two days before operation, 1 Gm. of streptomycin was given orally each day in divided doses, and on the day of operation 300,000 units of penicillin were given intramuscularly. When medication was started, the patient was placed on a non-residue diet; citrate of magnesia was administered to insure evacuation, and enemas were given routinely. On the last two preoperative days the food was limited to clear liquids. Glucose solutions and protein hydrolysate were given intravenously both before and after the operation.

At operation, the approach was made through a low midline incision which was extended slightly above the umbilicus. A large, firm, irregular mass involved the sigmoid and was attached to both the uterus and the bladder. It was separated from the latter organ without much difficulty, exposing an opening into the bladder which was closed. About 15 cm. of the sigmoid was removed, well above and below the involved area, followed by an open anastomosis with chromic catgut. It was impossible in this case to pass a colon tube from the rectum beyond the suture line, as is my usual practice in low resections. Therefore, the procedure was reversed by inserting the tube at the anastomosis line after the first two rows (posterior) of sutures were in place, then guiding it through the rectum and anus. The tube was adjusted and pushed beyond the suture line and the anastomosis was completed. A silk suture held the tube in position where it emerged from the rectum. A small cigarette drain was inserted to the bladder and brought out of the lower end of the wound. An indwelling catheter was placed in the bladder through the urethra. A slight amount of drainage was present for a few days. The colon tube was removed on the sixth day, and the catheter on the tenth postoperative day. Before the patient left the hospital, two weeks after the operation, she was having normal bowel movements and was voiding clear urine.

In August, 1948, the patient reported that she had been working steadily for over a year and had gained 30 pounds.

CASE 2. A man, 55 years of age, entered the hospital September 23, 1947. A week before, he had begun to have frequency and severe burning upon urination, following an acute exacerbation of recurrent diverticulitis. Preceding this episode the patient had become constipated, and after many attempts to evacuate the bowels by means of enemas, cascara, and suppositories, he had experienced pain in the left lower quadrant, followed by diarrhea with blood and mucus in the stools. These symptoms had subsided, and the pain had shifted to the lower mid abdomen. At that time the urinary symptoms had become evident, accompanied by chills and fever. The pain in the left lower quadrant had decreased, but the frequency and burning persisted, and the urine was cloudy and foul in odor. He had noted bubbling in urination during the last two days, and chills and fever, which had subsided, recurred.

The patient had lost 25 pounds in the past four or five months, and his general nutrition was poor. Blood pressure was 120 systolic and 80 diastolic; red blood cells numbered 3,590,000; white blood cells 12,450 (86 per cent neutrophils), and hemoglobin was 69 per cent. The urine was contaminated with fecal material. On September 24, roentgenologic examination of the colon by means of the barium enema showed complete obstruction to the retrograde administration of barium at the middle of the sigmoid flexure. Some irregularity could be seen at this point and probably one small diverticulum. The remainder of the colon was slightly distended by gas which ended abruptly at the middle of the iliac fossa.

Cystograms taken six days later showed an extensive filling defect of the left half of the bladder, the upper portion smooth, with some irregularity near the base of the bladder. The appearance was that of an extrinsic tumor pressing on the bladder and probably invading the wall.

Cystoscopic examination was performed October 1. Approximately 200 c.c. of thick, yellowish urine with a marked fecal odor was immediately evacuated. The entire left side of the bladder, beginning just above the ureteral orifice and extending up to the posterior-superior wall, was edematous and acutely inflamed, and although it could not be seen, the opening of the fistula was believed to be slightly above the left ureteral orifice.

Before the patient had been referred for operation, he had been given penicillin and sulfadiazine freely, but after he came under surgical supervision, sulfathaladine was substituted, and streptomycin, 1 Gm. daily in divided doses, was given for two days. Penicillin was discontinued until the day of operation, when 300,000 units were given twice daily and continued for one week.

The operation was performed October 6, 1947. Through a low midline abdominal incision the sigmoid was found to be densely adherent to the posterior wall of the bladder. It was separated by blunt dissection, and several chromic catgut sutures were placed in the raw surface of the bladder to close any opening which might have been present, although none could be demonstrated. Three pieces of gelfoam were used to cover the oozing surface. The involved area of the sigmoid was resected and an anastomosis done by the open method. A colon tube was inserted in the rectum and guided beyond the anastomosis; a Penrose drain was placed in contact with the raw bladder surface. The abdomen was closed in layers and steel wire interrupted sutures were used in the fascia. An indwelling catheter was placed in the bladder.

There was a small amount of thin drainage for five days from the lower end of the wound where the drain was placed. The drain was removed on the seventh day, and the catheter on the ninth. The rectal tube had been removed on the fifth day. Convalescence was without incident except for a rise of temperature to 102 degrees F. on the sixth postoperative day; it was normal thereafter. The patient was discharged, apparently well, ten days after the operation.

CASE 3. A man, 64 years of age, was hospitalized February 6, 1948. He had enjoyed fair health until the latter part of November, 1947, when he noted incontinence of urine and hematuria, and his temperature rose to 102° F. A diagnosis of virus pneumonia was made. The urine soon cleared, but the patient remained in bed for a month.

Early in January, 1948, a gastrointestinal survey, intravenous pyelogram, and blood studies were made, but no definite diagnosis was reached. Shortly thereafter fecal contamination of the urine was observed. Cystoscopic examination, on February 9, revealed a large cauliflower-shaped mass on the posterior part of the fundus, running up the posterior wall of the bladder. The medial lobe of the prostate was enlarged. Three days later, examination of the colon, by means of a barium enema, showed multiple diverticula of the sigmoid colon. At this point there was marked spasm and saw-toothed irregularity characteristic of diverticulitis. The mucous membrane in this region was not destroyed. A small column of barium, which appeared to be coming from the sigmoid, was directed medially and inferiorly in the general direction of the bladder and was thought to be the fistulous tract.

After the usual preoperative preparation and the administration of sulfathal-

adine for five days, streptomycin for two days and penicillin the final preoperative day, the patient was operated upon February 18. A long, low midline abdominal incision was made, exposing a large diverticulum of the sigmoid, adherent to the bladder. It was easily liberated, and a fistula was clearly seen between the bladder and the sigmoid. The opening in the bladder was closed with chromic catgut. The sigmoid was resected well above and below the involved area, and an open anastomosis completed. A colon tube was passed through the anastomosis before its completion, and manipulated so that it extended above the anastomosis and projected through the anus where it was anchored by silk suture through the perianal skin. The operation was completed as in Cases 1 and 2, and the same postoperative treatment was instituted.

The patient had a persistent cough, otherwise his course was similar to that of the other patients. He was discharged 18 days after operation without clinical evidence of a sigmoidovesical fistula.

When the patient was examined in August, an incisional hernia about 2 inches in diameter was noted. He had no urinary symptoms, and although he was troubled with emphysema and dyspnea on effort, he was able to follow his usual occupation as an insurance executive.

The gross pathologic appearance of the specimens removed at the three operations was relatively uniform, therefore the description of the one from case 3 will suffice. The section of colon was approximately 15 cm. in length, and it had been opened longitudinally. The external surface was pinkish gray, smooth and glistening, except for an area 4 cm. in greatest diameter in which petechiae were scattered in the serosa, and the walls were firm. The tabs of yellowish fat which adhered to the external surface were very firm and cut with increased resistance. The wall of the sigmoid measured 4 cm. in thickness. The mucosal surface was smooth and pinkish gray with very prominent rugae. The mucosa was freely movable over the submucosa. Cut sections in the region of induration and through the lobules of fat revealed numerous diverticula measuring approximately 3 cm. in greatest diameter; they contained fecal matter.

These 3 cases, illustrating a relatively safe and simple method of surgical treatment for the elimination of sigmoidovesical fistula, stand in contrast to the series previously reported. The one stage operation, which was regarded as hazardous, has, through the use of antibiotics, become the procedure of choice (figs. 5 and 6). Although improved methods of diagnosis, anesthesia and general preoperative and postoperative care have contributed to the success of treatment, the essential factor is the employment of antibiotics.

SUMMARY

Sigmoidovesical fistula is an uncommon complication of acute diverticulitis, but it is not so rare that it can be overlooked or forgotten. .

Although radical changes have been made in abdominal surgical procedures since the development of antibiotics, the application of these improved technics to the surgical treatment of this serious

complication of diverticulitis seems to have received no considera-
tion in the literature.

The diagnosis of sigmoidovesical fistula is strongly suggested by
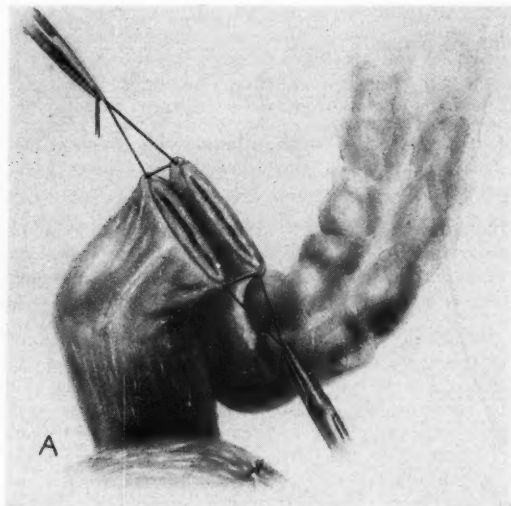a history of diverticulitis, acute or chronic, suddenly complicated by

Fig. 5. Approximation of sigmoid after resection of diverticulum.
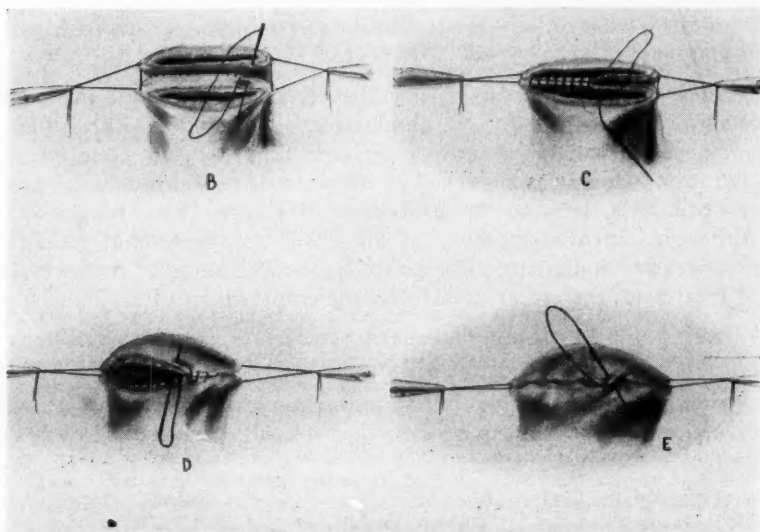

Fig. 6. Details of the anastomosis.

cystitis characterized by fecal contamination. Methods of further investigation consist of roentgenologic and urologic studies. The question of carcinoma may remain unanswered until after operation.

No operation, unless it be purely palliative, should ever be attempted in the presence of obstruction.

The preparation for operation consists in evacuating the colon and keeping it almost empty by restricted diet and catharsis. The discriminating use of sulfathaladine, streptomycin and penicillin will deprive the contents which remain of toxicity. The usual preoperative and postoperative measures in reference to fluids, blood, sedation and elimination are also observed.

External drainage through the lower end of the wound is recommended, as well as an indwelling catheter.

Colostomy is no longer an essential step. Sigmoidovesical fistulæ, as well as many other lesions of the colon, may be adequately treated by a one stage operation supplemented by antibiotics.

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USE OF BONE BANK BONE IN BONE SURGERY

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THE increasing number of encouraging reports concerning the use of refrigerated, homogenous bone for grafting purposes has resulted in general acceptance of the procedure. It is still in the experimental stage. Until recently, very little attention had been given to homogenous bone transplants, notwithstanding the fact that Macewen[1] reported successful bone transplantation from one person to another as early as 1878.

The ultimate fate of this graft is still uncertain. Carrell[2] in 1912 demonstrated that tissues could be preserved outside the body under certain conditions. He proved that the period which elapses between general death of the organism and cellular death varies with different tissues and under different conditions. In general, heat hastens and cold retards cellular death. The appearance of the tissue is no criterion. It is necessary to place tissue in a state of latent life under normal physio-chemical conditions to determine if it will manifest life. This is done by cultivation of the tissue or transplantation of the tissue. It is extremely difficult to cultivate bone tissue in order to demonstrate viable bone cells capable of reproducing bone. The investigations of Haas[3], Bush and Garber[4], Inclan[5], Reynolds and Oliver[6], and others, has not settled the question of whether or not living active bone cells remain in a transplanted graft. Most observers believe that few, if any, mature bone cells live after transplantation. This is probably true of both autogenous and homogenous grafts. There is some evidence to show that surface cells may live and multiply for a short time but eventually die and are replaced by tissues from the host.

There is no evidence to show that blood groups have anything to do with the success or failure of a homogenous graft. Are there specific bone groups? Does specificity of bone types play a part in bone regeneration? As yet, we do not know anything about possible bone groups, but, in the future this may play an important part in our clinical investigation. These and many other questions await a solution.

It should be emphasized that the use of homogenous bone is not intended to replace autogenous graft. It may be as good, or nearly as good, but it is not better than one's own bone. The pur-

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pose of a bone bank is to provide a supply of readily available bone when, for some reason or other, it is impossible or impractical to secure a sufficient amount from autogenous sources.

In young children it is difficult, if not impossible, to procure sufficient bone. Secondary operations in adults prolong the operative time, increase the dangers of the procedure and sometimes invite complications. The invasion of a normal tibia as a donor area carries with it the danger of infection and subsequent fracture. The hospital stay is lengthened and weight bearing must be delayed until the tibial defect partially fills in. A fracture usually occurs unless the extremity is protected for a long time. In young individuals the question of future growth of the extremity must be considered. It is a well established fact that bone grafts removed from a tibia in the active period of bone growth will usually result in from one-half to one inch actual increase in length of the extremity. When whole segments (fibula) are removed or cancellous iliac bone obtained, certain risks are still present.

Many patients are quite willing and ready to undergo a grafting operation, but refuse when told that they must submit to a second operation for removal of the necessary bone. Not a few, chiefly women, object to multiple scars. In some instances, such as extensive scoliosis or large cystic bone defects, it may be impossible, regardless of any other factor, to secure enough bone to satisfy the purpose of the operation.

Two methods of preserving homogenous grafts have been described. One is the preservation of the bone in a 1:1000 solution of aqueous merthiolate advocated by Reynolds and Oliver. The other is the refrigerated method preserving the bone in a deep freeze unit at a temperature of minus ten to twenty degrees centigrade. The reader is referred to the paper by Bush[7] which describes the method in detail. Our bank is operated on this method. Thus far, we have had no trouble with it, and it seems to be more physiological than the chemical process.

Source of Bone

In the beginning, it seemed that the procurement of an adequate supply of bone would not be difficult. Excess bone removed in the course of any operation from young, healthy individuals, free of syphilis, cancer, malaria or any known infectious disease is suitable for storing. Clean amputation specimens provide an excellent source of both cortical and cancellous bone. The increasing demands on the bank demonstrate that it is very difficult to provide a sufficient supply of bone from these sources alone. This is especially true if

several surgeons are using the same bank. Perhaps in the future we shall develop community or possibly district bone banks to supply all of our needs. We are convinced that with the increasing use of homogenous bone, we shall have to rely on fresh cadaver bone from healthy adults who have met a sudden, traumatic death, despite the many technical and legal difficulties entailed. The bank cannot remain solvent in any other way as far as we can predict.

All specimens are cultured before being frozen and stored, and a careful record is kept. We do not usually culture a second time, or before the graft is used, provided a negative culture was obtained in the first place. If only one specimen from a batch shows contamination, the remainder is preserved for use.

The length of time refrigerated bone can be kept, and still retain useful properties, has not been definitely established. In one case in our series, bone which had been stored eight months was successfully transplanted. Generally speaking, it is used within a period of sixty to ninety days after being obtained. We believe, however, that it should not be used until a negative culture has been reported, except where bone is transferred directly from one individual to another.

Table one summarizes the use of homogenous grafts in forty cases. There were only three infections, each of which was caused by the relighting of an old quiescent osteomyelitis. The graft was lost before union had a chance to occur. These cases were considered failures. All the remaining cases healed per primam. There was no reaction of any kind. There was no evidence that blood grouping has the slightest thing to do with successful homogenous grafts.

We believe the host bone should be as carefully prepared for the reception of a homogenous graft as for an autogenous graft. The donor graft, in turn, should be placed so that its raw surface is in contact with a similar area of the host. The principals governing bone grafting procedures which have been developed over the past 20 years are certainly as applicable in this instance as in any other situation. The fundamental conception of the role of circulation in any successful grafting procedure must be utilized and employed to the fullest extent, regardless of whether the graft is a homogenous one or an autogenous one.

Fixation of the graft should be by whatever method the operator prefers. In some instances it is sufficient to place cortical strips of homogenous bone adjacent to a fracture which has been reduced and fixed by other means.

In children, these grafts seem to be incorporated into spine grafts

TABLE 1

Summary of 40 Cases

SPINE FUSIONS:
  1. Tuberculosis 5
  2. Scoliosis 3
  3. Disc and fusion operations.............................. 9
  4. Spondylolisthesis 1

FUSION OF JOINTS OTHER THAN SPINE:
  1. TBC hip 2
  2. TBC ankle 1
  3. Subastragular joint (traumatic arthritis)................... 1
  4. Posterior bone block of ankle............................ 1

BONE BANK BONE USED IN CAVITIES OR DEFECTS:
  1. Giant cell tumors 2
       (a) humerus
       (b) femur
  2. Compound fracture defect 1
  3. Other defects 2

NON UNION:
  1. Radius 1
  2. Tibia 2
  3. Femur 1
  4. Congenital fracture of the tibia......................... 1
  5. Ununited intertrochanteric fractures 2

BONE BANK BONE USED IN FRACTURES COMBINED WITH OPEN
  REDUCTION AND PLATING:
  1. Mal-union of radius 1
  2. Humerus 1
  3. Femur 3
                                                            ___
       TOTAL.. 40

INFECTIONS: 3

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more quickly than in adults. The chances of success in spine fusions in children is greater than in adults but the total period of immobilization is somewhat longer. Bank bone has proved invaluable in spine fusions in cases of scoliosis, and where an extremely large amount of bone is necessary. It could not possibly be secured from autogenous sources without considerable risk and danger to the patient. As a rule, it should be emphasized that when bone bank bone has been utilized, it is necessary to add to the total period of immobilization and fixation of the fracture. This is particularly true in adults where a non-union is present. In our experience, the greatest usefulness of bone bank bone consists in its application to supplement and augment autogenous bone in spine fusions and also

in supplementing the internal fixation of fracture of long bones wherein a plating procedure is necessary. In the latter instance, we have found great success in applying strips of cortical bank bone around the fracture site after the method of Paul Steel and Phemister. We definitely believe that the presence of bone bank bone enhances the development of callus and early union. The metallic internal fixation provides immobilization of the fragments while the healing process is going on. Table five summarizes and enumerates the results which have been obtained in cases of this kind.

TABLE 2

Spine Fusions

Condition	No.	Success	Failure	Infection	Remarks
TBC	5	4	1	1	
SCOLIOSIS	3	3	0	0	
SPONDYLOLISTHESIS	1	1	0	0	
DISC REMOVAL AND FUSION	9	5	1	0	3 cases too recent to evaluate
TOTALS	18	13	2	1	3 cases too recent to evaluate

In Table two the results of spine fusions are tabulated. It is admittedly difficult to evaluate the degree of fusion in any spine arthrodesis, particularly those in the lumbo sacral area. We have attempted to analyze our cases from the standpoint of clinical fusion; fusion demonstrated on the x-ray, and relief of pain and symptoms which brought the patient to surgery in the first place. We find that bank bone and autogenous bone used simultaneously and arranged in a carefully prepared bed is perhaps the best procedure. Chips of bone turned up from the lamina and the spinous processes are reinforced with strips of cortical bank bone from one end of the fusion area to the other. Internal fixation other than secure suture of the muscles over the grafts is not employed. We prefer to use a large amount of bone. No external fixation is applied. The patients are kept in bed for six weeks, then permitted to become ambulatory with a low-back brace.

Bone cavities remaining after operations for osteomyelitis or giant cell tumors should be completely filled and tightly packed with bone chips. Occasionally, one finds that there is considerable absorption of the bone so placed, indicating, perhaps, a lack of com-

TABLE 3

Joint Fusions Other Than Spine

Joint	No.	Success	Failure	Infection	Remarks
TBC HIP	2	1	1	1	One hip fused with excellent result. One failed, infection.
TBC ANKLE	1	0	1	0	No breaking down of incision, but graft absorbed. No fusion —extension of TB abscess.
SUBTALOR TRAU-MATIC ARTHRITIS	1	1	0	0	Joint fused. Some pain persisted however.
POSTERIOR BONE BLOCK ANKLE ..	1	1	0	0	Excellent block. Graft well incorporated.
TOTAL:	5	3	2	1	

TABLE 4

Bank Bone Used to Fill Cavities or Defects

Cavity or Defect	No.	Success	Failure	Infection	Remarks
GIANT CELL TUMOR FEMUR..	1	1	0	0	Cavity filled in. Patient back to work. No pain.
GIANT CELL TU-MOR HUMERUS..	1	1	0	0	No pain. No weakness in arm. Cured.
COMPOUND FRAC-TURE CAVITY ...	1	1	0	0	Excellent result.
BENIGN TUMOR ULNA RESECTED.	1	1	0	0	Tumor resected. Replaced with large cortical graft. Complete regeneration.
LOCAL PAGET'S OF TIBIA	1	1	0	0	Resection of area replacement with large cortical graft. Success.
TOTALS	5	5	0	0	No failures.

patability of the host and the homogenous grafts. Whether this indicates bone specificity or not, we cannot say. The end results,

however, seem to be as good, if not better, as when pure auto-genous bone is used.

TABLE 5

Non Union

Bone	No.	Success	Failure	Infection	Remarks
RADIUS	1	0	1	1	Old osteomyelitis re-lighted. Graft was lost. Non union still present.
TIBIA	2	2	0	0	One case success. Other case apparent-ly so. Follow-up time not long enough.
FEMUR	1	1	0	0	Solid union and good result.
CONGENITAL FRACTURE TIBIA .	1	1	0	0	Third dual graft with homogenous bone. Result good so far.
INTERTRO-CHANTERIC	2	1	1	0	One case united, the other had hip joint disarticulation be-cause of Charcot's joint.
TOTALS	7	5	2	1	

Bank Bone Used in Fractures of Long Bones to Supplement Plating at Open Reduction

Bone	No.	Success	Failure	Infection	Remarks
MAL UNION RADIUS	1	1	0	0	Good result.
HUMERUS	1	1	0	0	Excellent result. Large amount cal-lus. Graft well in-corporated.
FEMUR	3	3	0	0	Excellent results all cases.
TOTALS	5	5	0	0	

CASE 1. J. D., male, age 47. Preoperative diagnosis: Ununited fracture of the right tibia. Patient first seen Feb. 16, 1949, 13 weeks after fracture sustained. Figure 1 shows no evidence of callus and there was free motion
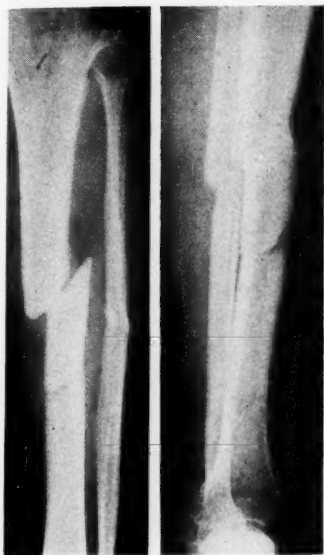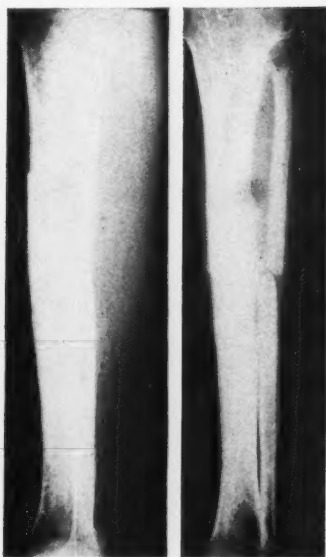
Fig. 1 (Case 1). Ununited fracture of   Fig. 2 (Case 1). Four months after
the tibia.   plating and homogenous bone graft.
                                               Solid union.

between the fragments. Operation February 18, fracture reduced, the bones freshened, a cortical strip of bone bank bone was laid adjacent to the fragments on the posterior medial aspect. Fixation obtained by means of a vitallium plate. The bone graft was not fixed to the tibia. Postoperative course uneventful, no infection or reaction. Union clinically solid in $9\frac{1}{2}$ weeks when brace was fitted. Last seen on July 7, clinically solid union and by x-ray. Patient bearing full weight without support. Successful result.

CASE 2. M. B., female, age 10. Preoperative diagnosis: Giant cell tumor upper right humerus. She sustained a minor trauma in June, 1948. X-ray revealed an extensive giant cell tumor with a fracture through the cyst. Operated July 6, the tumor tissue was curetted out and the specimen sent to the laboratory. Diagnosis of giant cell tumor confirmed. The cavity was filled with bone chips obtained from the bone bank. We did not have sufficient bone to pack the cavity tightly and some bone was removed from the patient's right ilium. Postoperative course was uneventful. Figure 1, condition before operation. Figure 2, 3 weeks after operation. Figure 3, 3 months after operation, showing excellent filling in of the defect. Figure 4, 1 year and 6 months following operation. No symptoms. Clinically, she is completely well.

Fig. 1 (Case 2). Extensive giant cell
tumor, preoperative.

Fig. 2 (Case 2). Three weeks after
operation. Filling in of cavity with
homogenous bone grafts.

Fig. 3 (Case 2). Three months post-
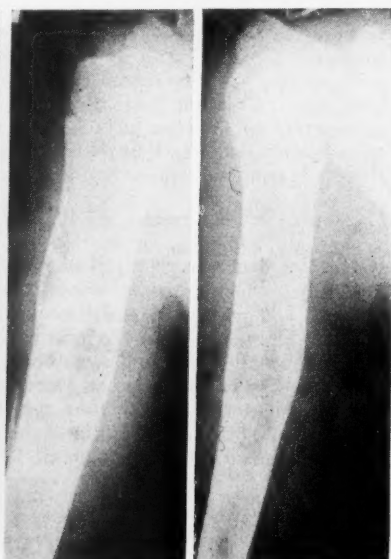operative. Excellent filling in of cavity.

Fig. 4 (Case 2). One year and six
months after operation. Some recur-
rence of cystic regeneration but no pain
or symptoms.

Fig. 1 (Case 3). Benign fibro-cartilag-
inous hyperplasia.

Fig. 2 (Case 3). Three weeks after ex-
cision of pathological area and homog-
enous graft. Marked bony proliferation
about the graft.

Fig. 3 (Case 3). Six months after op-
eration. Complete incorporation of the
graft into the tibia.

CASE 3. B. C., female, age 5. First seen April, 1946. History: Two years before being seen, the right shin turned black and blue without history of definite trauma. Since then the tibia has been bowed forward and there is a hard area over the front of leg. Examination revealed marked anterior bowing of the tibia with cystic degeneration and a fibro cartilaginous condition of the bone. Biopsy in April, 1947, revealed a benign fibro cartilaginous hyperplasia. June, 1949, the anterior (fig. 1) one-half of the tibial cortex including the enlarged pathological area was completely resected. All involved tissue was thoroughly curetted out. A long strip of cortical bank bone was inserted into the cavity so that the upper end was driven into the medullary canal of the tibia, and the lower end of the graft was held with a vitallium screw. Figure 2, 3 weeks postoperatively showing extensive proliferation of the homogenous graft. Figure 3, 6 months postoperative showing complete incorporation of the graft into the tibia and obliteration of the defect. Excellent result. No further trouble.
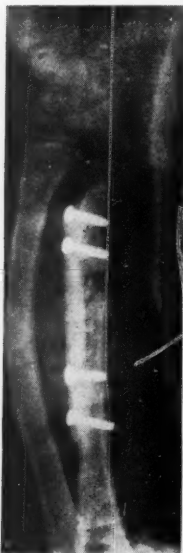

Fig. 1 (Case 5). Condition following removal of exostosis and replacement with homogenous graft.

Fig. 2 (Case 5). Thirteen months postoperative showing complete incorporation of graft of the ulna.

CASE 5. J. L. S., male, age 9, white. This patient had a large benign exostosis from the lower end of the ulna which was interfering with function of the arm. The tumor was excised and the defect replaced by a large cortical homogenous graft. Unfortunately, the first x-rays have been lost. Figure 1 shows the forearm after the tumor had been excised and the graft applied. Figure 2 shows the arm 13 months after operation. The graft has completely healed and has been incorporated into the host bone.
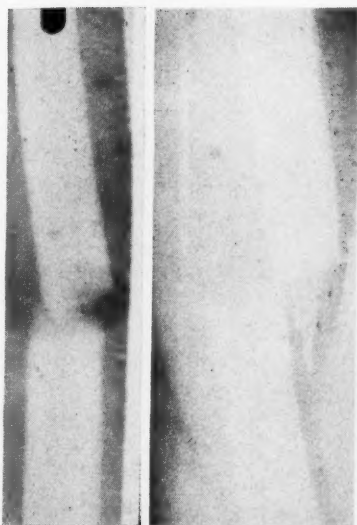
Fig. 1 (Case 6). Fracture of humerus unsuccessfully treated by hanging cast.

Fig. 2 (Case 6). Three months after plating and homogenous bone graft. Note solid union and excessive callus formation.

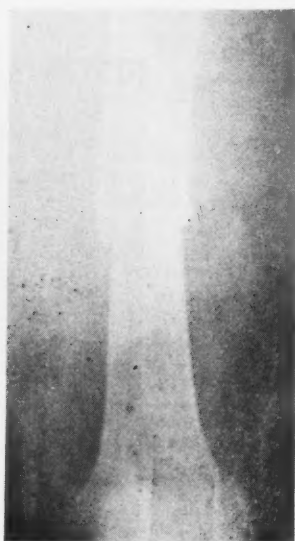
Fig. 1 (Case 7). Fracture of the shaft of the femur.

Fig. 2 (Case 7). Six months after reduction and plating with application of a cortical homogenous graft. Graft united to the proximal fragment does not appear to be necrotic.
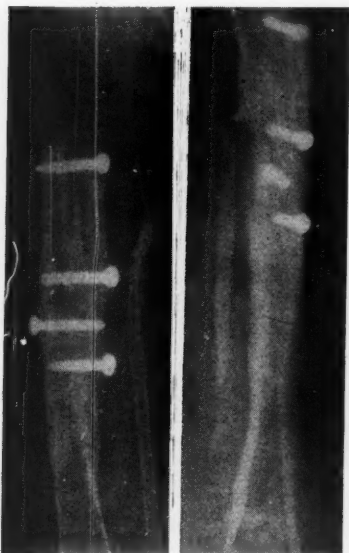
Fig. 1 (Case 8). Congenital fracture of the tibia. Nine months following dual bone graft. Fracture apparently united but non-union recurred.

Fig. 2 (Case 8). Union has melted away and fracture is still ununited ten months later.
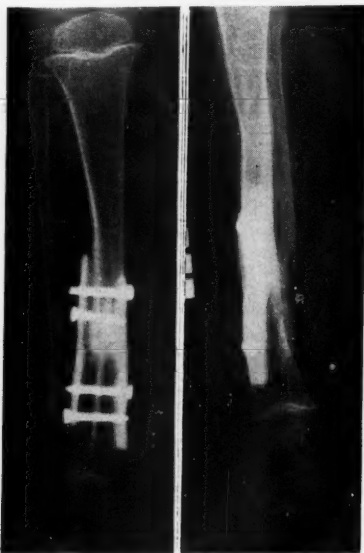

Fig. 3 (Case 8). Four months following third homogenous dual bone graft. Note dense sclerotic condition of graft but union of fracture.

CASE 6. F. W., white male, age 63. This patient sustained a transverse fracture of the mid-third of the left humerus on Feb. 9, 1949. He was first treated in a hanging cast unsuccessfully. On February 14 an open reduction and application of vitallium plate, in addition to a cortical homogenous graft was done. Postoperative and hospital course was uneventful. Patient dismissed to go home on tenth day. Incision healed per primam. Figure 1, humerus preoperative. Figure 2 shows abundant callus. On May 10, 3 months after operation, solid union. Note graft is completely incorporated into the callus.

CASE 7. L. S., female, age 66, white. Fracture shaft left femur on May 16, 1948. Treated by traction until June 10 when an open reduction was done because of unsatisfactory position and diagnosis of muscle between the fragments. At operation fracture was reduced, vitallium plate used for fixation and a cortical homogenous graft was laid down on the opposite side. No infection, no complications. Figure 1, fracture before operation. Figure 2, fracture 6 months after operation, showing solid union. Note appearance of the graft. The upper one-half is well fused to the host. It does not appear dense and white as one would expect if it were dead and necrotic.

CASE 8. L. P., male, age 3, white. Congenital fracture of the tibia. This child had three dual bone grafts using homogenous bone. Each graft seemed to be successful for a while but the union subsequently melted away and failure ensued. Figure 1, 9 months following homogenous graft. Graft united but non-union recurred. Figure 2, union has melted away. Ten months later than Figure 1. Figure 3, 4 months following the last graft October 4. Result so far seems good. Extremity still being protected.

SUMMARY

The use of bone bank bone for a variety of conditions has been discussed.

Our experience with this method in 40 cases has been reported.

Homogenous refrigerated bone is not superior to fresh, autogenous bone.

The combined use of homogenous and autogenous bone may eventually prove to be the best combination for best results.

Use of refrigerated homogenous bone offers considerable promise in the further development of bone graft surgery.

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SPINAL FUSION FOR SCOLIOSIS EMPLOYING REFRIGERATED AUTOGENOUS BONE

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A TWO-STAGE procedure for spinal fusion is to be preferred for patients deemed as questionable operative risks. This is particularly applicable in the surgery of patients with severe deformities secondary to poliomyelitis; in which, in addition to the general debilitation evident in victims of chronically disabling diseases, there are serious depletions in the reserve capacities of the pulmonary circulation and the respiratory system. Inclan[10] in discussing the merits of the two-stage procedure stated that in spinal fusions for the treatment of Pott's disease, or for the fixation of a previously corrected paralytic or structural scoliosis, the operative procedure was frequently attended by shock. He graphically compares the temperature, pulse and respiration of five patients fused in a single stage procedure with five patients utilizing either autogenous or homogenous preserved bone grafts, and notes the ease of control of shock and dehydration in the later group.

The resection of the prominent ribs on the posterior aspect of the thorax, on the convex side of the scoliotic curve, was described in 1930 by Buchman[4] in outlining the previously performed procedure. Whitman,[16] in 1927, described the procedure utilizing the resected ribs as bone grafts for the spine fusion. Bickel, Hinche, and Clagett in discussing a one-stage combined resection of the ribs and spine fusion state that in some instances the operation was performed in two stages owing to the general poor condition of the patient and to the length of the procedure.[3]

The possibility of thoracoplasty producing a scoliosis towards the side of the resection is presented by Cleveland[7] and mentioned by Compere[8] in his discussion of Bickel et al one-stage procedure. Wenger[14] states that as long as the transverse processes are not removed the resection of ribs has little effect on the production of a scoliotic curve.

In addition to the cosmetic effect of the thoracoplasty, the resected ribs provide ideal bone graft material for the spine fusion which serves to arrest the progression of the scoliotic curve. Their normal curve will be found to almost exactly approximate the curve of the area for fusion, and the fact that they are composed of both compact and cancellous elements provides both structural strength and

osteogenetic material. Abbott, Schottstaedt, Saunders, and Bost[1]
state the following regarding ribs as grafts: that the cortical bone
of the ribs behaves much like the cortical bone of the tibia when
used as a graft, although it is less dense and more readily vascular-
ized; that there was a rapid formation of new osteogenetic tissue
about the trabeculated elements as compared to the slow and
restricted process of creeping substitution occurring in the cortical
portion. They concluded that it formed a quicker and better attach-
ment to the host than in the case of tibial bone, and stressed the
point that revascularization is much more rapid in the split rib graft
than in the whole rib because of the greater area of medullary sur-
face exposed.

The superiority of autogenous bone as material for grafts has
been pointed out by Albee, Murphy, Carrel, Loeb and others. Loeb
states that the order of success in grafts is in the following order:
autogenous, syngenesioplastic, and homogenous. The use of homog-
enous preserved grafts is thoroughly discussed by Bush in his pre-
liminary report of the Bone Bank,[5] and mention is made of the use
of preserved autogenous grafts in a series of 30 patients. The use
of autogenous ribs for grafts precludes the complaint of some
patients of an operative scar over a plainly visible area, a psycho-
logical barrier mentioned by Henry.[9]

The use of a two-stage procedure has been greatly facilitated by
the use of refrigeration as a means of preserving the graft; although
the same two-stage procedure was frequently performed using the
tissues of the patient as the site for the preservation of the resected
grafts. Inclan made use of autogenous, preserved bone in 43 cases,
storing the grafts in sterile glass containers partially filled with
citrated blood. His grafts were refrigerated at a temperature of
from plus 2 to plus 5 degree Centigrade for periods ranging from
3 days to 63 days, the largest number of cases being preserved
for 7 days. The methods of refrigeration at the New York Ortho-
pædic Hospital were either regular refrigeration for one to three
weeks at a temperature of from plus 2 to 5 degrees Centigrade; or
deep freeze at a temperature of minus 25 degrees Centigrade. Grafts
were stored in two glass bottles, sterile and screw capped, with a
cover of rubber and gauze placed over the mouth of the outer,
larger bottle.[5] Reports of the storage of skin grafts at freezing
temperatures have been made by Matthews,[12] and Strumia and
Hodge.[18] The former using an ordinary household refrigerator
and the latter utilizing frozen plasma as a storage medium at a
temperature of from minus 20 degrees to minus 25 degrees Cen-
tigrade.

CASE REPORT

The patient was a 15 year old white male, admitted to the hospital for surgical treatment of a severe scoliosis. The curve of the scoliosis had its convexity to the right and was centered in the lower thoracic region. The patient had poliomyelitis when he was a small child and was treated for this first by the Kenny regimen and then by body casts and braces. Except for wearing a brace he had had no treatment for several years prior to being seen by us a short time before admission to the hospital. There was a very marked prominence of the right ribs posteriorly. Chest expansion was severely limited on the right side. The patient's height was 51 inches, his weight 60 pounds and his blood pressure 90 over 60. The apex of the curve was at the ninth thoracic vertebra and the curve measured an angle of approximately 65 degrees. On stretching, the patient was able to achieve a height of 53½ inches. Lateral bending and tilting of the pelvis decreased the curve only a few degrees. There was a marked pelvic tilt to the right. The Trendelenberg sign was negative. Examination of the abdomen was essentially negative except for marked displacement of the liver and spleen. Following several weeks of hyperextension on a bent Bradford frame with traction on the head and feet, a thoracoplasty was performed by a chest surgeon. The usual periscapular incision was used and segments of five ribs were resected subperiosteally. At the time of the operation it was noticed that the bodies of the rotated vertebrae were immediately beneath the ribs which were excised. The patient stood the operation very well. A serious postoperative complication developed as far as the immediate progress of the case was concerned which consisted in the development of an area of pressure necrosis in the middle of the scar. This developed even though the patient was not replaced on the hyperextension frame but instead was allowed to lie freely in bed. Pressure on the incision which lay over the prominence of the kyphos was undoubtedly responsible for this. A great deal of time was consumed in healing this ulcer which was quite refractory to treatment even following removal of all the necrotic skin and subcutaneous tissue. By the end of four and one-half months after the operation, the area was entirely healed.

Five and one-half months after the thoracoplasty the patient was operated upon again and a spine fusion procedure done employing the ribs previously removed at the thoracoplasty operation. These ribs had been stored in an ordinary home deep freeze mechanical refrigerator at approximately 9 degrees below zero Centigrade. The most strict aseptic precautions were used in taking and storing the ribs. The patient stood the spine fusion procedure very well in spite of the fact that he was very small physically and had a markedly reduced vital capacity in his chest and some circulatory incapacity there. Beginning a few days after the operation, the patient was placed on the hyperextension Bradford frame again with traction on his head and feet. He tolerated this very well and there was no tendency for the ulcer to reform in the previous thoracoplasty scar. The patient was left on the bent Bradford frame six weeks.

X-rays made six weeks after the spine fusion operation showed a great deal of new bone formation and a satisfactory beginning fusion. A new molded leather brace was made for the patient. A cast was applied for making the brace and this was done with the patient suspended by his head and stretched as much as possible. The patient continued to do well and by the end of 12 weeks had a solid fusion. As a result of the spinal fusion the spine was held

rigidly in a position about 10 degrees less curved than originally. It was felt that the fusion operation will, in all probability, prevent further progression of the curve which was progressing steadily preoperatively. The size of the kyphos posteriorly was moderately diminished and its appearance considerably improved by the thoracoplasty.

Fig. 1. X-ray made 6 weeks after spinal fusion operation using refrigerated ribs removed previously from the same patient. The ribs and new bone formation are visible across the convex side of the curve.

COMMENT

The case reported in this paper is of particular interest on a number of accounts. The resected ribs were stored in an ordinary home deep freeze unit at a temperature of minus 9 degrees Centigrade. They were at the time of the thoracoplasty wrapped in sterile gauze. They were inserted into a sterile, empty, glass, screw top bottle, and this was in turn wrapped with a sterile cloth. The elapsed time between the resection of the ribs and their insertion at the time of the spine fusion was five and a half months. This long period of time was necessary because of the complication of the development of an ulcer in the center of the thoracoplasty operative wound. Apparently the long period of freezing did not injure the grafts as an unusual amount of bone had formed six weeks after the spinal fusion procedure.

Summary

1. The indications for a two-stage combined thoracoplasty and spine fusion are presented and its superiority brought out.

2. A partial review of the literature on preserved bone grafts is presented.

3. The superiority of autogenous grafts is presented, and the favorable properties of resected ribs as grafts for spinal fusion are presented.

4. A case is reported in which resected ribs preserved in an ordinary home deep freeze refrigeration unit at minus nine degrees Centigrade for five and one half months was used successfully as grafts in spine fusion.

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SOME TECHNICAL PROBLEMS ASSOCIATED WITH
COMPLICATED MALIGNANT LESIONS
OF THE COLON

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I wish to discuss two of the major complications that are encountered in the surgical management of cancer of the colon. They are those related to obstruction and those associated with fixation and local extension of cancer.

Acute obstruction of the colon is reported not to be very common; however, we have had a sufficient number of acute obstructions to form certain opinions and standardize an effective technic for decompression. The frequency of acute colonic obstruction is difficult to determine.

In large clinics where patients are brought from afar the incidence is low, while in congested centers it rises materially. Also an estimation of what an acute obstruction of the colon is varies. It is sufficient to say that it is a very large dilatation of the colon, sufficient to produce abdominal distress and obvious abdominal distention.

The frequency as reported by Rankin was 5 per cent, Gregg and Dixon 5.5 per cent, Rea, Smith and Schwyzer 15.2 per cent, Campbell 30 per cent plus, Burgess 35.6 per cent, Graham 16 per cent, and Scott, White, Brindley (190 cases) 20.6 per cent, University of Minnesota, Dennis (367 cases) 9.54 per cent. We have a percentage approaching these reports, there being 12 acute obstructions in 100 cases of cancer of the colon and 8 moderate obstructions, upon which colostomy was done within one to two days after entering the hospital because of progressive obstruction.

MORTALITY

Michel, McCafferty state that the mortality rate of operations is usually based upon the rates of all surgeons in a given hospital and not of one or a selected few. We do not think this is a fair estimation of mortality rate. We think only those results from competent surgeons in the field should be recorded.

I think this report gives an unhappy, unfair evaluation of the procedure of proximal colon decompression for the various causes of colon obstruction. When they report 30 deaths in 103 cases, or 29.1 per cent, with a distribution of *no deaths in five cases of diver-*

ticulitis to 24 or 32.4 per cent in 74 cases of acute malignant obstruction, we are sure that this does not represent their personal experience. It is the assembled report of a mêlee of surgeons, trained and untrained in colon surgery.

The operative mortality from surgical decompression of the proximal distended colon is excessive. Brusgaard's report of 13 deaths in 91 cases of volvulus is high but not excessive when you consider a volvulus often is devitalized and requires resection.

Wangensteen, Dennis, et al. report a very low mortality rate. Brindley reports 7 deaths in 34 cases of acute malignant obstructions. We had 4 in 20 and none in 10 others performed by our present method using our colostomy clamp. This method is simple, practically aseptic and requires no great hurry in removing the clamp or irrigating the bowel as it can not redistend.

Colon obstruction is insidious in onset and gradual in progression, except it be a volvulus of the colon. Therefore, it may progress to a marked degree before being suspected unless one is careful to note the history of progressive obstipation and change in bowel habits. Too often these patients are treated for a period of time for constipation, spastic colitis, peptic ulcer or operated upon for appendicitis. The symptoms are often abdominal in character and not related directly to the obstructive lesion. The clinical manifestations of abdominal colic, forceful, visible peristalsis and borborygmus are present but in lesser degree than in acute small bowel obstruction. The acuteness of the two lesions are not the same; the symptoms and x-ray findings are different. Vomiting is reflex in character and largely an attempt by nature to empty the stomach and put the intestinal tract at rest. So in like manner the distal segment of the colon may empty itself, as there is nothing wrong with the anatomy and physiology of that segment of the colon. This is more frequently observed in small bowel obstruction and frequently gives a false assurance of security.

The abdomen in a thin individual shows the contour of the distended colon and on the right side the distended cecum can often be outlined. Until acute obstruction actually occurs, often little attempt is made to study the patient and arrive at a correct diagnosis, though abdominal pain, altered bowel function and passage of blood by the rectum are present. It often develops progressively without being suspected until the seriousness of the situation suddenly becomes apparent. •

Colon obstructive lesions are of three kinds: malignant, inflammatory and strangulated. It is no serious mistake to err in the immediate differential diagnosis between malignant and inflammatory

obstruction, but to do a colon decompression for a volvulus obstruction of the sigmoid is fatal. When doubt exists it is wise to explore the sigmoid by an appropriate incision and if a volvulus is not present to do a right transverse colostomy.

X-ray of the obstructed colon does not give as much information as in obstruction of the small bowel. It does not indicate the level of the obstruction nor the nature of the lesion. It does show a distended proximal colon with its characteristic haustral markings but the exact site of the obstruction is often obscure. Localization of the lesion can be determined by a barium enema, if the obstruction is complete, and it is then no obstacle to surgery. It can be readily evacuated by enema. It is only when the obstruction is incomplete that subsequent difficulty may be encountered by barium enema. The proximal colon may become impacted with dehydrated barium. It may convert an incomplete obstruction into a complete one. Barium should never be given by mouth in obstruction of either the small or the large bowel.

The pattern assumed by a distended colon is one that conforms to the anatomical position of the colon and it usually shows the characteristic haustral markings. As the colon becomes more distended, because of the closed loop nature of the obstruction, these characteristic haustral markings of the colon are not well seen.

Care must be taken to carefully interpret the gaseous distribution and patterns seen in the intestinal tract. It must be remembered that gas is normally seen on a scout film, in the stomach and in the colon of an adult but not observed in the small bowel. Colon gas may be small or great in amount and a well defined distention of the proximal colon with gas must be present before a diagnosis of colon obstruction can be made. When gas is seen in the small bowel it is suggestive of interference with bowel continuity. The small bowel assumes a pattern transverse to the long axis of the body in simple obstruction and shows the volvulae conniventes well, while a strangulated small bowel obstruction presents no gaseous pattern and the volvulae conniventes are not seen. These are fine points of radiological interpretation but they can be well differentiated by a competent radiologist.

Colon obstruction would seem to be a simple obstruction in which there would be a progressive dilatation of the colon and the small bowel. It is, on the contrary, no such simple affair. It soon becomes a closed loop obstruction because of the competency of the ileocecal valve. This is completely so in over 50 per cent and partially so in the remainder. No colon contents regurgitates into the terminal ileum, but, on the contrary, the ileum continues to empty its contents

into the cecum. An incompetent ileocecal valve permits some reflex into the ileum and moderate small bowel dilatation. This should not be confusing. The colon gas predominates.

The colon, therefore, becomes progressively distended and is in reality a double obstruction in which the blood supply soon becomes inadequate to maintain bowel viability. The segment of the colon most distensible is the cecum, the walls of which become extremely thin and ultimately become gangrenous and perforate. This closed loop type of colon obstruction is, therefore, in part comparable to a strangulated or a volvulus type of small bowel obstruction. It is in reality as much of an emergency as small bowel strangulation. Therefore, surgical decompression should not be long deferred, else gangrene and rupture of the cecum will occur. We have observed this twice, and in one instance it occurred pending abdominal preparation for colon decompression. Cecostomy, however, was immediately carried out, and fortunately there was little abdominal soiling and recovery occurred. Subsequent resection of the lesion was successfully done.

Obstruction presents a complication which prohibits a primary attack upon the lesion, which is quite in contrast to that of small bowel obstruction. In colon obstruction the problem is to decompress the colon and prepare it for subsequent resection of the lesion, while in small bowel obstruction surgery is directed primarily at removal of the lesion. Not only in acute obstruction is decompression desired but also in all cases of chronic obstruction of the left colon, preliminary proximal bowel decompression is indicated. Only in a clean, nonobstructed colon can primary resection and anastomosis be safely performed.

Lesions of the left colon are usually annular, constricting in character and at the time of consultation have a variable degree of obstruction and a few have complete obstruction. Fortunately, most apparent obstructions are not complete but are in part due to associated edema, inflammatory reaction and prolapsed mucous membrane. Under proper surgical decompression and by irrigations the obstruction may relent sufficiently to permit the colon to partially empty itself through the distal segment. This materially aids the thorough cleaning of the colon.

Obstructive lesions of the right colon may be decompressed by cecostomy with or without ileocolostomy. If the obstruction is definite but incomplete, it is quite appropriate to do an ileocolostomy as a preliminary step to right colectomy.

Surgical decompression for lesions more distal can be done by cecostomy or transverse colon colostomy, the latter being preferable

if the lesion is low in the left colon. However, in complete obstruction with extensive proximal bowel distention this is not always easy. Often the distended right transverse colon is pushed high under the liver by the enormously distended cecum, which displaces everything well toward the midline and upward, so the transverse colon is difficult to approach and deliver.

Strauss has emphasized the superior value of ileostomy over cecostomy or colostomy in obstruction of the colon and has insisted that the distended colon can be more quickly deflated by passing a colon tube through the ileostomy into the cecum. We have tried this procedure twice and have found it undesirable. The colon can not be irrigated and cleaned for future surgery. Skin irritation discredits the procedure.

PROCEDURE FOR COLON DECOMPRESSION

In acute colon decompression we deflate the distended bowel by needle puncture, grasp the deflated bowel with a flat, no tooth, thumb forcep at the point of needle puncture and apply our special colostomy clamp to the small suspended cone of bowel; close the abdomen around this small protruding segment of colon and then insert into the colon, through the round opening in the clamp, a 16 or 18F. catheter. This procedure exteriorizes only a small segment of the colon but gives an adequate vent for gas through the catheter.

This does not completely divert the fecal current and it is only advocated for an acute obstruction due to cancer where resection is subsequently contemplated. The clamp can be removed in two to three days and bowel irrigations may be started. A loop colostomy with subsequent transection of the bowel is probably better for acute diverticulitis with abscess, as it completely detours the fecal current.

Figure 1 shows the blunt thumb forcep grasping the bowel at the site of needle puncture. The clamp with round ring is being applied and a small cone of bowel is shown above the clamp.

Figure 2 shows the abdomen closed around the clamp and the enclosed bowel and an 18 F. catheter inserted into the colon through the ring and fixed by one suture through the protruding cone of clamped bowel.

Figure 3 shows clamp in place and catheter inserted through opening in clamp into the bowel.

Figure 4 shows healed operative incision and colostomy stoma retracted flush with the abdominal wall.

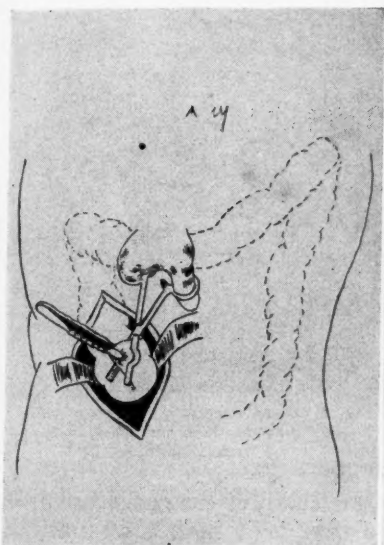Figure 5, small complementary colostomy stoma made by use of the clamp at time of resection.

Fig. 1. Clamp being applied to elevated cone of deflated cecum.
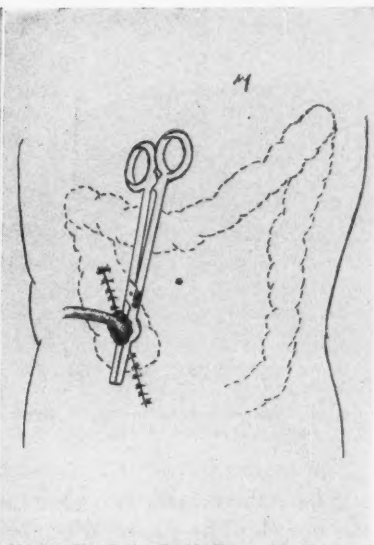*Clamp made by V. Mueller & Co., Chicago, Ill.

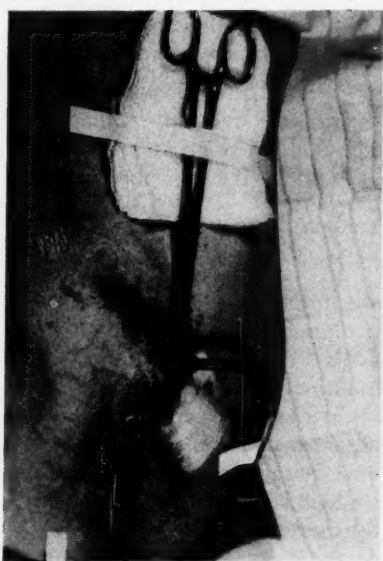Fig. 2. Clamp in place, abdomen closed, catheter inserted into bowel through ring in clamp.

Fig. 3(a). Segment bowel supported by closed clamp and catheter in bowel.
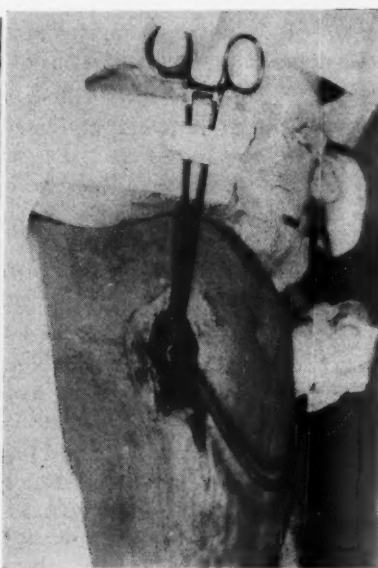
Fig. 3(b). Larger segment of bowel above skin level, supported by clamp and catheter protruding into colon.

Fig. 4. Appearance Cecostomy 4 weeks later. Cecostomy of Fig. 3(b).   Fig. 5. Complementary Colostomy made at the time of resection and primary anastomosis.

The catheter acts as a vent for gas and prevents redistention of the bowel. The clamp is removed later or it sloughs off and the bowel is then irrigated and cleansed.

We do not favor the Devine colostomy for those obstructions whose lesions we hope subsequently to resect. The Devine colostomy is too time consuming, too complicated and too difficult to close. It is not appropriate in a distended colon as a temporary decompressing agent.

Loop colostomy is difficult to do in acute colon obstruction even though the colon is decompressed by needle puncture. A distended bowel is hard to deliver. It is not possible in the distended cecum. It is no more effective than the method we have described nor is it as easy or aseptically done.

COMPLEMENTARY DECOMPRESSION

Complementary cecostomy or colostomy accompanying resection and primary anastomosis of a left colon or sigmoid lesion is not to be condemned. It is commonly practiced by many capable surgeons. We have recently adopted it as a routine. We use the same clamp adapted for catheter insertion as previously described. It gives a vent for accumulated gas and prevents tension upon the suture line. The subsequent closure of the stoma is a small procedure. Spontaneous closure has occurred. The added security is considered well worth the minor inconvenience. By this method, there is no large amount of bowel protruding outside the abdomen. It is not distasteful, as it usually is flush with the abdomen or slightly retracted below skin level.

EXTRINSIC EXTENSION OF CANCER

Because of our desire at all times to avoid a colostomy and to remove the lesion when anatomically possible, we have progressively expanded the scope of surgery for cancer of the colon, even though we know the resection is palliative.

PALLIATIVE COLOSTOMY

Palliative colostomy is usually a procedure to be condemned. It gives no palliation, adds little to the patient's life but contributes much to his discomfort. It is uncontrollable and has contributed much to discredit colostomy performed in association with removable lesions. The pain and discomfort accompanying an unremoved, malignant lesion, are attributed to the colostomy, rather than to the progress of the disease.

A palliative colostomy is indicated only in advanced colonic malignancy, associated with extensive involvement of the liver or generalized peritoneal metastasis, with impending obstruction. In many instances of such advanced states, colostomy can be avoided by anastomosing around the lesion and preserving the fecal current, or for the brief period of life remaining, a diet without residue or liquid in character, will obviate the annoying effects of a terminal colostomy.

Many patients who have large, fixed lesions, or lesions involving adjacent intestines, abdominal wall, pelvic structures, bladder, prostate or posterior vaginal wall, have too frequently been declared inoperable and a premature palliative colostomy has been done. We have in former years, because of inexperience and lack of courage, performed such ill advised procedures, and have subsequently learned that a more venturesome surgeon has successfully removed some of these lesions. We, likewise, in recent years, have removed lesions previously pronounced inoperable elsewhere.

PALLIATIVE RESECTION

Palliative resection may add much to the patient's comfort and length of life, and far exceeds in benefit a short circuit operation around the lesion or a colostomy. Pain and pressure from the growth of the lesion is abolished by palliative removal. Moderate metastasis is no contraindication to resection and the removal of adjacent involved structures, along with the lesion, when possible, is to be encouraged. Resection, even in the presence of incurability is, therefore, strongly urged. The patients live longer and are more comfortable, even with metastasis, when the lesion is removed.

FIXATION AND EXTENSION

Fixation is often present in colon cancer and removal may jeopardize vital surrounding anatomical structures if caution and care is not exercised in finding a line of cleavage. These structures may be isolated above or below the fixed lesion, followed to the point of involvement and separated with greater certainty of protection. We have found this useful in isolating an adherent ureter or in freeing lesions of the iliac colon from the great vessels.

Lesions involving an adjacent loop of small bowel are removed en masse and tubes, ovaries and uterus may be excised along with the cancer if adherent and involved. Rectosigmoid lesions involving the posterior wall of the bladder have been extirpated along with a segment of the bladder. The anterior abdominal wall in part has been removed, as has the surrounding parietal peritoneum and the underlying muscle in lesions involving the lateral abdominal wall. In two instances the entire left lobe of the liver was removed, because of a large isolated metastatic lesion, in the course of the abdominal phase of a Miles resection. All this we have done and do without hesitation when it is apparent it can be done with benefit to the patient.

These extensive procedures have made postoperative recoveries about as satisfactory as those uncomplicated resections. With careful dissection, good anesthesia and plenty of supporting blood, long, tedious procedures can be successfully performed.

OBJECTIVES

Two objectives are emphasized in this paper: one is related to early surgical decompression of acute colon obstruction and the other urges the radical surgical resection of many fixed and expanding lesions that are too often thought to be inoperable. A method of colon decompression is described which in our experience is safe, adequate and subsequently easily closed. The mortality of colon decompression by this method has been with us greatly reduced.

Palliative colostomy is condemned and palliative resection within reason is urged in all lesions anatomically suitable for resection.

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SURGICAL TREATMENT OF PORTAL HYPERTENSION

A Review of Reported Clinical Experience and an Evaluation Based on Consideration of Physiological and Pathological Factors

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S OME diseases of the liver and spleen have always been of a perplexing nature. Diagnosis has been difficult and treatment has been largely inadequate. The cause of hemorrhage from esophageal varices, and the formation of ascites are two facets of the problem which have long been recognized to be of great difficulty in treatment. Of recent years portal hypertension has been found to be a common factor in these two clinical problems which occur in diseases of the liver and spleen. New methods of treatment and modifications of older methods have come into prominence. The final solution is by no means reached, but an evaluation of present treatment of a surgical nature can be made in the light of the knowledge of the physiology and the pathology of the portal circulation, the liver, the spleen, and the collateral circulation.

Portal hypertension by definition refers to the elevation of hydrostatic pressure within all or part of the portal venous system. The elevation of pressure may be due to various causes, known or unknown, though all of them may be classified as intrahepatic or extrahepatic. That portal hypertension exists has been proven by Thompson and Whipple and others.[1] The increase in venous pressure within the portal system has long been suspected on the basis of pathological findings and clinical course, but it was not until direct measurement at laparotomy that it was placed beyond doubt.[1,2] By these direct measurements it can be seen that the normal portal pressure is 80 to 100 mm. of saline higher than the normal peripheral venous pressure (Table 1). Other diseases of the spleen such as hemolytic jaundice and purpura do not show elevation of portal venous pressures. Laennec's cirrhosis, schistosomiasis, and splenic vein thrombosis do show elevation of portal venous pressure. The early work of Herrick, McIndoe, Warthin, and McMichael led to this final precise, unassailable measurement. Herrick and McIndoe perfused cirrhotic livers to arrive at their conclusions.[3,4] Warthin was impressed by the thrombosis occurring in the veins,[5] and McMichael likened the splenic vein changes to those occurring in arterial hypertension and congestion of other organs.[6] The papers of Larrabee did much to cause the adoption of the term "congestive splenomegaly."[7]

Intrahepatic causes of portal hypertension:

Portal or Laennec's cirrhosis is the commonest of the intrahepatic causes of portal hypertension. Portal cirrhosis is also the most frequent cause of portal hypertension in general as well. Other types of cirrhosis, biliary cirrhosis, syphilitic scarring, toxic cirrhosis and schistosomiasis occasionally have been found to be the cause of a portal hypertension. Herrick[3] investigated the mechanisms of the rise in portal pressure occurring in cirrhosis of the liver. He found that in the normal liver during perfusion experiments, a rise of 40 mm. in the arterial pressure gave a rise of 1 mm. in the portal pressure. In the cirrhotic liver, however, a rise in only 6 mm. in the arterial pressure gave a rise of 1 mm. in the portal pressure. He concluded that a far freer communication between the arterial and portal currents existed in the cirrhotic liver than in the normal liver. He stated that factors contributing to the increase in portal pressure in portal cirrhosis are direct communication of the arterial pressure to the portal vessels through dilated capillaries and larger volume flow of the hepatic artery in proportion to the portal flow. McIndoe[4] strongly emphasized the physical obstruction of the cases of portal cirrhosis as the chief factor in the increase of venous pressure and the production of ascites. In perfusing the normal liver he recovered 100 per cent of the solution perfused from the hepatic veins, while in the cirrhotic liver he recovered 13 per cent at most from the hepatic veins.

	Venous Pressure mm. H_2O or saline	
	Arm or Leg Vein	Portal System
Range of normal venous pressure (Bellis)	50-120	140-220
Seven cases of Hemolytic Jaundice (Thompson)	80-205	105-275
Three cases of Purpura (Thompson)	65-300	70-190
Seven cases of Banti's syndrome with Laennec's cirrhosis (Thompson)	12-190	205-470
Six cases of Banti's syndrome with Schistosomiasis (Thompson)	50-125	250-500+
One case of Banti's splenic vein thrombosis (Thompson)	170	390

Table 1. Comparison of venous pressures. Note that the normal portal venous pressure is reported as 80-100 mm. of saline higher than the normal peripheral venous pressure. Note also that other diseases of the spleen (purpura, hemolytic jaundice) are not associated with elevation of portal pressure.

Portal hypertension as a cause of hematemesis and ascites is a vitally important factor in the entire disease complex of cirrhosis. Hematemesis occurs in 27 per cent of Laennec's cirrhosis according to Ratnoff's and Patek's[8] analysis of 535 cases, and in about 10 per cent it is the presenting symptom. Of the 106 patients suffering hematemesis, 55 died following the episode. Thirty-three died from the initial episode of bleeding, while the remainder had more than one episode before succumbing. In this series there were nine additional patients who had melena but no hematemesis.

Analyzing their figures further, it is found that of the patients having hematemesis, 40 per cent died within one month, and most of these died within one week. An additional 30 per cent died within a year. They considered their patients dying shortly after the first hematemesis to be those in whom jaundice, ascites, and torpor are permanent. The group surviving for a longer length of time after hematemesis, they considered to be latent cirrhotics in which they suspected a weakness in the vascular structure. Experience of other authors does not substantiate this latter conclusion. In all, bleeding was the cause of death in one quarter of the total number of cirrhotics. From this it can be concluded that hematemesis is a significant cause of death and disability in cirrhosis and is worthy of consideration for treatment. It is fully realized that increase in portal pressure is only one cause of bleeding in portal cirrhosis, and that diminished liver function and lowering of the blood prothrombin is another important cause. The prothrombin deficiency should not be underestimated.

Portal hypertension is also of importance in contributing to the formation of ascites. Serum albumin is the determining primary factor in ascites and portal hypertension plays a contributing part. That is, portal hypertension appears to determine the site at which the transfer of fluid takes place. Of 386 patients reported, 78 per cent had ascites and in most cases this was accompanied by leg edema, usually following the ascites in time of occurrence. Sixty-four patients had both ascites and hematemesis.

Though the production of ascites and edema is primarily due to the lowered serum proteins, the lowering of the portal venous pressures should decrease the incidence of ascites. For this reason as well as preventing the morbidity and mortality of hematemesis, the increased venous pressure in the portal system is worthy of attention.

There is no doubt that the portal hypertension is worthy of attention in some cases of cirrhosis of the liver. Great caution will have to be used in selection of patients for surgical treatment for the worth of surgical procedures will be very little if the patient is to

die shortly of hepatic insufficiency. The majority of cirrhosis cases will fall into this group which will be little benefited by a surgical attack on one aspect of the clinical picture while liver failure with its multiple derangements is a greater threat to life. Some clinicians believe that surgical procedures for hematemesis and ascites are not warranted at all since the life expectancy of the patient with manifested cirrhosis is short. As with so many other diseases, individualization of the treatment must be carried out. It is impossible to state categorically which patients should have the benefits of surgical therapy without a careful evaluation of each case.

Extrahepatic causes of portal hypertension:

Extrahepatic obstruction of the portal system may be due to many causes. Thrombosis of the portal and splenic veins occurs secondary to inflammation, or trauma, or possibly secondary to tumor invasion or compression.[9] Congenital stenosis of the portal vein may occur and stenosis from adhesive bands may be a possibility. Thrombosis or endophlebitis of the hepatic veins is known to be associated with a portal hypertension. Cavernomatous transformation of the portal vein is associated with a portal hypertension. All of these clinicopathologic entities have one factor in common, obstruction of the portal venous flow outside of the liver.

There are multiple causes of thrombosis of the portal and splenic veins. Beginning chronologically the first cause of extrahepatic block is thought to be an extension into the portal vein of the obliterative thrombotic process which takes place in the umbilical vein and ductus venosus at the time of birth.[10] It is this type of obstruction which is thought to be the cause of portal hypertension, splenomegaly and Banti's syndrome in infants and young children. Thrombosis or obstruction of the portal system can be secondary to trauma and inflammation. There is the now well known case (Whipple[10]) of a young healthy man who suffered severe trauma to the upper abdomen resulting in rupture of the pancreas and formation of a pancreatic cyst. Three years later he was found to have a splenomegaly, anemia, leukopenia, thrombocytopenia and had had two severe attacks of hematemesis. At operation the splenic vein was obstructed by scar at the site of the old pancreatic injury. Splenectomy was performed and the patient is alive and well nine years postoperatively. Inflammation of the biliary and pancreatic systems, previous abdominal operations and abdominal thrombophlebitis have been considered to be other etiological agents of the obstructive process. Cavernous transformation of the portal vein is another pathologically recognized, though rare, cause of portal hypertension.[11] Most pathologists consider this condition to be a later

stage of portal vein thrombosis with subsequent canalization and growth of highly vascular granulation tissue, though others have considered it to be a congenital malformation or an actual neoplastic process.

There remains the possibility that portal hypertension may be caused by other than organic venous obstruction and this involves a discussion of the etiology of Banti's syndrome. Banti originally described a disease of chronic course, having three stages. The first stage of anemia, splenomegaly, asthenia and occasional gastro-
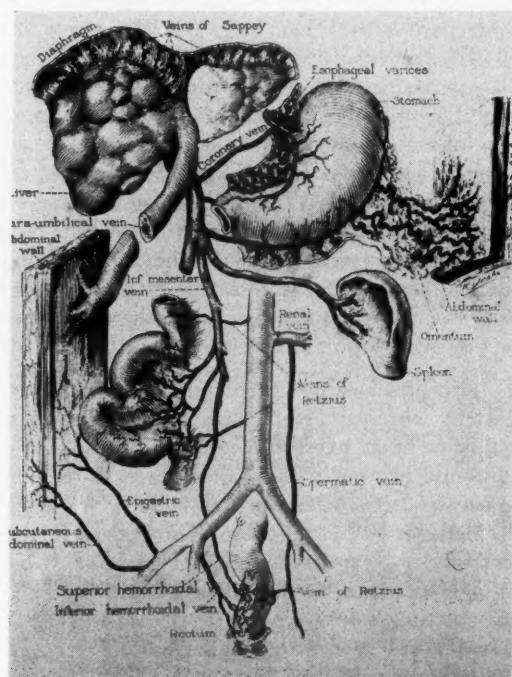
Fig. 1. Schematic representation of the collateral circulation in portal cirrhosis. Note, in addition to the coronary-esophageal system, the veins of Sappey and Retzius and the channels formed by adherence of omentum to the abdominal wall. (From A. McIndoe, courtesy of *Arch. Pathology.*)

intestinal hemorrhage was followed by the second of oliguria, urobilinuria, hepatomegaly, brown discoloration of the skin and increasing gastrointestinal hemorrhage. The third stage ends in ascites, atrophy of the liver, generalized hemorrhagic tendency, icterus and death from hemorrhage or liver insufficiency. An essential part of Banti's hypothesis is a toxin manufactured by the spleen causing

liver cirrhosis. It is quite evident now that cases of "Banti's syndrome" as commonly used to describe the clinical picture of anemia, leukopenia, thrombocytopenia, splenomegaly and a tendency to gastrointestinal hemorrhage are not always associated with liver disease. Larrabee[7] first suggested the term of congestive splenomegaly to describe more accurately this disease picture. Moschcowitz[12] has summed up the current opinion when he states that ". . . the fact that portal hypertension is the only common denominator in these various types speaks strongly that this factor is the exclusive one, especially when one considers that the biological progression maintains a consistent order throughout, and in more or less direct relation to the distance from which the obstruction arises, the duration of the hypertension and to a lesser extent the height of the portal pressure." The evidence strongly indicates that the splenic changes are secondary to the increased portal pressure and not primary as originally postulated by Banti and others (Moschcowitz). The splenic changes are not influenced by the etiology of the obstructing lesion. Numerous cases have come to operation with no obstructive factor noted and some cases have even come to autopsy without the demonstration of the obstructing lesion, all therefore being termed case of "unknown" origin. Moschcowitz believes there are no cases of "unknown" origin and that careful study will always demonstrate the cause for production of the hypertension of the portal circulation. In cases of Thompson and Rousselot[13] of New York which have come to autopsy, there was never the failure to find an obstructive factor. Ravenna[14] has suggested that a primary increase in arterial inflow is the cause of Banti's syndrome and that the organic vein disease and thrombosis are secondary. McMichael,[6] although one of the first to realize the importance of the venous congestion in the production of the pathological changes in the spleen, thinks that an additional factor causing cellular proliferation of the spleen is necessary to explain the degree of enlargement which is found in Banti's disease. The bulk of the evidence supports the "obstruction" theory.

Why and where patients with portal hypertension bleed:

Other than the factor of increase in pressure within the portal system there are other factors which must be considered in answering the question of why patients bleed and why they bleed most frequently from esophageal varices. The ruptured esophageal varix is the commonest cause of bleeding and a gastric varix is a much less common cause. Lower regions of the gastrointestinal tract can also be a source of bleeding but this bleeding is not of great significance. Hemorrhoids may be prominent but seldom cause serious trouble.

In obstruction of the portal venous system, collateral channels between the portal system and caval system have been divided into three groups (McIndoe,[4] fig. 1). The first of these channels develop in the gastrointestinal tract where absorbing and protecting epithelium meet, that is, at the cardia and at the anus. At the anus anastomoses are detected between the superior hemorrhoidal vein of the portal system and the middle and inferior hemorrhoidal veins of the caval circulation. Clinically, this can be manifested as hemorrhoids. At the cardia the coronary vein of the stomach and its branches anastomose with the esophageal veins of the stomach which empty into the intercostal, azygos and diaphragmatic veins of the caval system. Esophageal varices are thereby produced.
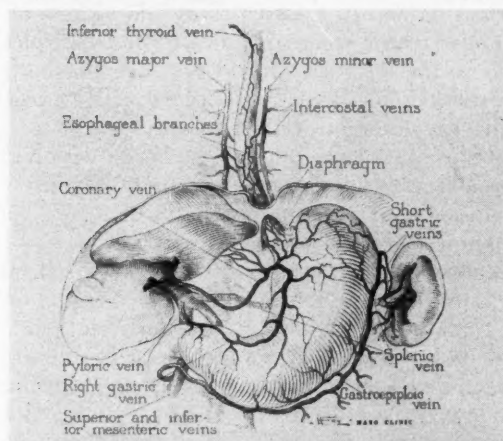
Fig. 2. The coronary vein of the stomach and its connections with the esophageal veins (from D. L. Kegaries, courtesy of *Surgery, Gynecology and Obstetrics*).

The second group, less important, is at the site of the obliterated embryologic circulation, that is, the falciform ligament. The caput medusae of the paraumbilical veins is the clinical expression of the flow of this group. The third group comprises all locations within the abdomen where the gastrointestinal tract and its derivatives becomes adherent to the abdominal walls either developmentally or pathologically. The channels involving the duodenum, small intestine, colon, omentum, spleen and pancreas are termed the veins of Retzius and the channels involving the liver are termed the accessory veins of Sappey. Adhesions from pathological processes may occur anywhere in the abdomen and serve as channels between the portal and caval systems, the most conspicuous concerned with portal hypertension being those about the spleen.
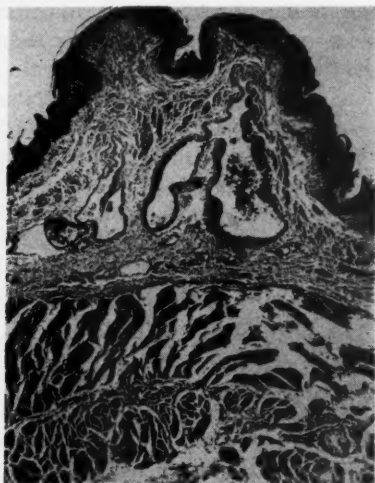
Fig. 3. Esophageal varices. Microphotograph (X32) illustrating the vulnerable position of these vessels. (From D. B. Phemister, courtesy of *Annals of Surgery*.)
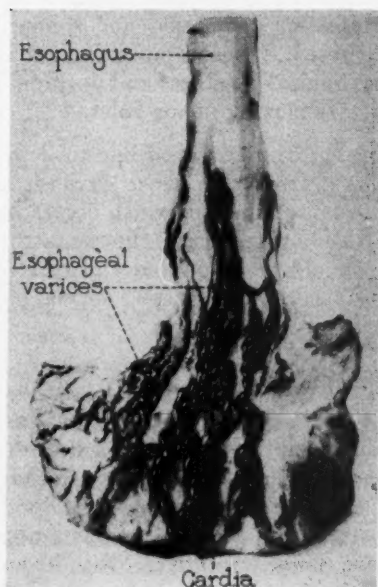

Fig. 4. Case of portal cirrhosis. Esophageal varices injected with gelatin and india ink, after the mucosa had been stripped off. (From A. McIndoe, courtesy of *Arch. Pathology*.)

Regardless of the amount and location of collateral circulation
we know from clinical experience that the only channels offering an
immediate threat to the life of the patient are the collateral path-
ways formed by the anastomosis of the coronary vein and its
branches with the esophageal veins (fig. 2). This pathway is prob-
ably carrying a greater portion of the blood because it is near to
the site of obstruction and negative pressure in the thorax further
predisposes to the flow of blood in that direction.[15] The esophageal
veins are thought to be especially prone to hemorrhage because the
submucosa plexus of veins is poorly supported by loose connective
tissue (figs. 3, 4). The veins at the cardia are more strongly sup-
ported due to increased thickness of the muscularis interna and the
greater adherence of the mucosa (Kegaries[16]). In the stomach and
less frequently in the esophagus, acid and peptic erosion occur. It is
estimated that 10 per cent of patients examined roentgenologically
show incompetency of the cardia, thus allowing reflux of gastric
secretions into the esophagus. Wangensteen[17] has shown that dogs
with portal hypertension are more predisposed to gastric ulceration
when treated with the histamine in beeswax preparation than are
normal dogs. If the acidity and peptic content of the gastric juice
predispose to hemorrhage in clinical cases it is not on the basis of
definite ulcer formation, for this is rare. Usually only small erosions
are seen at esophagoscopy or autopsy and frequently the bleeding
point cannot be identified. It seems more likely that bleeding occurs
due more to the anatomical weakness and position of the veins with
peptic and acid factors playing minor roles.

The portal hypertensive may bleed due to depressed liver func-
tion and low plasma prothrombin, when cirrhosis is the obstructing
lesion. Also the thrombocytopenia which occurs so frequently may
contribute to the bleeding tendency. These factors should not be
minimized. They should be diagnosed and treated whenever pos-
sible. Bleeding episodes continue despite normal blood prothrombin
value and platelet counts.

Introduction to therapy:

Classification of the operative procedures used therapeutically in
portal hypertension depends on the approach to the problem. Since
control of the bleeding from the gastrointestinal tract is one object
of therapy, alleviation of the abnormality of blood platelets, leuko-
cytes and erythrocytes, prevention or reduction of ascites and re-
moval of the splenic tumor are others, all to be accomplished with-
out compromising the function of vital organs and all are to lead
to general improved health, the surgical procedures devised and
practiced are many and varied.

Procedures directed at control of bleeding from the gastrointestinal tract may be separated into procedures to obliterate or remove the vessels predisposed to bleeding and procedures to shunt the blood to the caval circulation thereby decreasing the likelihood of bleeding by lowering the portal venous pressure. The latter of these two general procedures has much to recommend it on general physiological grounds from the standpoint of bleeding, not to mention its concurrent depressive effect on the formation of ascites. In addition, other procedures directed solely at the problem of ascites involve techniques for the drainage of the ascitic fluid out of the body or back into the general circulation.

The treatment of the splenic tumor, thrombocytopenia, leukopenia, and anemia is splenectomy. It is to be realized that frequently combinations of surgical procedures have been used and can still be recommended on the basis of the available evidence. Extreme caution should be used in the evaluation of the procedures for portal hypertension, more so in the cases of extrahepatic obstruction which are known to have a longer life expectancy without treatment than the intrahepatic obstruction cases which are complicated by hepatic insufficiency. Gastrointestinal hemorrhage has been known to be nonexistent for many years only to have it again appear and cause severe morbidity and death. Improvement in ascites due to surgery may be in reality due to improvement in serum proteins from medical therapy.

Obliterative therapy:

The obliterative type of therapy has many facets and has been carried out in one of its many forms for many years. Though large series of cases have not been reported, ligation of the coronary veins has fallen into disuse due to lack of satisfactory persistent results.[18] Likewise, ligation or stripping of the periesophageal veins is no longer practiced. Injection of the varices with sclerosing solution through the esophagoscope, first suggested and performed by Crafoord, is more recent and has been more successful. Moersh[19] reported on 22 cases followed at least 3 years, 12 of which had no bleeding postinjection for periods of 3 to 7 years. Of the 10 continuing to bleed, 3 died of massive hemorrhage and 3 have died of other causes in addition to the bleeding. His results were independent of age or sex of the patient, the duration of the illness or the frequency of bleeding episodes. He explained his poor results in part by the bleeding of varices in the cardia. Sixteen of the patients had been subjected to splenectomy before injections were begun and 3 were splenectomized after injection therapy. Patterson[20] had similar experiences with this therapy. Of 4 patients first seen in

shock, 2 were controlled by injection and 1 controlled by injection and tamponage while 1 could not be controlled and expired from bleeding. Of 24 total patients, 6 died of hemorrhage despite therapy. On the basis of frequency of hemorrhagic episodes occurring before injection therapy he calculated in 17 patients with cirrhosis that the expected number of hemorrhages would be 64 for the postinjection period. Only 8 bleeding episodes actually occurred. In 4 patients following splenectomy the number of anticipated hemorrhages was reduced from 27 to 2 actual ones. This procedure then obviously has some value and is to be recommended to stop profuse bleeding as well as treatment for long term results. Its value in poor surgical risk patients is also obvious. Concerning emergency treatment of the patient with esophageal varices, the intraesophageal venous tamponade, revived by Rountree[21] promises to be of even
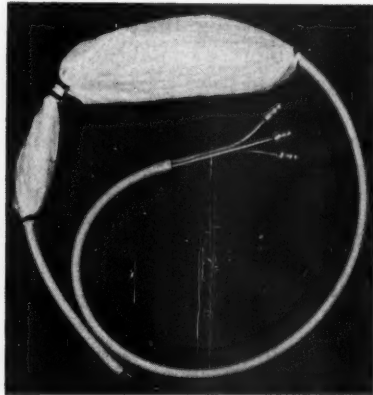

Fig. 5. Double balloon tube of Elliott and Kennamore. Small balloon is inflated after tube is passed into stomach. When tube is withdrawn until lower balloon is snug against cardia, the upper larger balloon is inflated giving esophageal tamponade. Continuous suction or tube feeding may be given through the tube end remaining in the stomach. (From Kennamore and Elliott, *Gastroenterology* and unpublished data.)

greater value than injection of varices. Various modifications of an inflatable rubber bag attached to a gastric tube have recently been announced. Elliott and Kenamore[22] (fig. 5) use a Miller Abbott tube cut to a length of 60 cm. Fifteen centimeters from the distal end of the tube a latex balloon is attached so that the openings of one lumen will permit inflation. Aspiration or injection may be accomplished through the distal tube while the bag is inflated distending the esophagus and compressing the varices. Coating of the balloon with topical thrombin is also used to induce coagulation. A later modification of the tube involved two separate bags. The distal bag

is inflated after passage of the tip into the stomach, the bag is pulled up against the cardia and then the second more proximal bag is inflated within the esophagus. This should have additional value in controlling varices at the cardia which Moersch has found to be a cause of bleeding even though the esophageal varices are controlled.

The more formidable attempts to obliterate the bleeding vessels in the stomach and esophagus are total gastrectomy and esophago-gastric resection. The reasoning of removing the vessels most likely to bleed from the circulation is the same as for injection therapy or ligation therapy, but the operation excels in thoroughness and completeness both of these procedures but adds a much greater operative risk. The published experience is as follows: Phemister[23] performed a total gastrectomy for Banti's disease, the patient surviving two and two-thirds years with only one moderate and one slight episode of bleeding. In another case he performed an esophagogastric resection for Banti's disease with the patient followed up for three and one half months without bleeding. He admits that the operation is unphysiological, but thinks nevertheless it may be justified, especially in cases in which hemorrhage cannot be controlled by splenectomy, shunt and injections. Wangensteen[17] performed three extensive gastric resections. Two patients have survived two years without hemorrhage and 1 patient is dead one year postoperative. There is some evidence that the new channels which are formed when the portal circulation is blocked will continue to bleed even though the high venous pressure is relieved. The large thin walled vulnerably placed varices of the esophagus may continue to rupture though the pressure within them is greatly lowered. If this is true resection of the lower esophagus and stomach will be found to have a more preferred therapeutic place.

Results of splenectomy alone:

Splenectomy alone for Banti's syndrome has not given good results. This therapy would not be expected to give good result if the obstructive lesion is other than very close to the spleen. Whipple[10] has said that only 5 per cent of cases of congestive splenomegaly will be cured by splenectomy alone. Of course, splenectomy in intrahepatic causes of portal hypertension would certainly not be expected to give a cure. The rationale behind splenectomy is to relieve the hypersplenism, the depression of platelets and leukocytes and anemia first of all. The spleen is said to receive 20 per cent of the blood flowing to the abdominal viscera and therefore it is reasoned that removal of this organ will relieve the portal venous system of a considerable amount of returning blood. Even

after splenectomy in cases of an obstructing lesion close to the
spleen, the persistence of the collateral circulation, namely the
esophageal varices, may continually dispose the patient to further
episodes of bleeding. Barg and Dulin[24] compared the course of
splenectomized and unoperated patients in which the diagnosis of
Banti's syndrome had been made. The age of the patients were 5
to 75 years and since no mention was made of intra or extrahepatic
etiology it is assumed that these were cases of both intra and extra-
hepatic lesions. Of 22 surgical patients there were 8 operative deaths.
Twelve patients were followed and 4 were alive and well two to nine
years postoperatively. Three died from gastrointestinal bleeding,
2 were alive but suffering episodes of bleeding, 2 were classified as
improved and 1 dead from cause unknown. He noted a favorable
effect on ascites and noted improvement in the blood picture. It is
most interesting to note that 4 patients who had no hematemesis
previous to operation developed hematemesis postoperatively. Of
the 17 medical patients with the same diagnosis followed up to nine
years, 11 were dead, 10 dying within the first year. Of 4 living
patients followed up to two and one half years, 2 had progressive in-
crease in their symptoms and 1 was alive for four years with an occa-
sional small gastrointestinal hemorrhage and 1 was alive nine years
in good health. Smith and Farber[25] reported 15 cases of splenom-
egaly, anemia, hematemesis and nonprogression of the disease to
cirrhosis and ascites in children. Eleven of these children underwent
splenectomy; of these only 3 having no recurrence of hemorrhage, 1
followed only three months and the other 2 followed for five and
eight years. There was 1 postoperative death. All of the remaining
7 had one or more bouts of bleeding postoperatively, death occurring
from hemorrhage in 4. Three of 4 children in whom splenectomy
was not performed died of hemorrhage, the 1 surviving contin-
uing to hemorrhage. Splenectomy operative mortality in large
series of cases of splenic anemia are reported as from 12.5 per cent
to 25 per cent. In these series of cases, an equally high or higher
incidence of hemorrhage was noted postoperatively than preopera-
tively. In Eliason's[26] compilation of published experience with
splenectomy in splenic anemia, the long term survival was equally
unimpressive. Pemberton reported a five year survival of 55 per cent
and a 10 year survival of 43 per cent but his figures stand much
higher than those of Eliason, who reported a five year survival of 28
per cent and a 10 year survival of 21 per cent, and Rousselot, who
reported a five year survival of 20 per cent and a 10 year survival of
10 per cent. Eliason also reviewed the report of Howells,[27] who
considered 43 per cent of splenectomized patients to be improved
as contrasted to 46 per cent improvement from medical therapy.

Classification of the cases and details of the medical regime were not stated. A highly illustrative report of the value and limitations of splenectomy is that of Rousselot.[13] Of 15 cases of splenic anemia not related to cirrhosis, 9 cases did poorly, 6 cases did well. Seven of the 9 have died following bleeding episodes, 2 were alive and having bleeding episodes. In 6 of the 7 dead, the obstructive factor was detected at autopsy. Four of the obstructive factors were in portal vein, 2 were in the splenic vein. Of the cases living without bleeding, 2 of the 6 cases have proven obstructive lesions (laparotomy) and these were both in the splenic vein. One would not expect splenectomy to benefit permanently those cases with portal vein block, but why did splenectomy apparently cure 2 cases of splenic vein block while 2 other cases of splenic vein block were not benefited by splenectomy? Of the splenic vein block cases which continued to bleed, Rousselot explained as having a block in the vein proximal to the coronary vein. He believes that a block occurring distal to the entrance of the coronary vein into the portal vein will allow the venous return from the spleen to reenter the portal system, thus lessening the bleeding tendency. He, too, emphasized the adequacy of the splenectomy for the splenic tumor, the thrombocytopenia, the leukopenia and anemia, but not the hemetamesis and portal hypertension. From his report it must be obvious that judgment as to the final results of any operative procedure for congestive splenomegaly must be withheld for longer periods of time since splenectomy alone in several cases was accompanied by freedom from hematemesis and otherwise good health for a long as nine years, then only to have bleeding recur and result in death of the patient. A risk of splenectomy must be mentioned. In those cases of Banti's syndrome having high platelet counts, an additional risk of further venous thrombosis sometimes results in a fatality.[28,29]

Shunt therapy:

The shunting of blood away from the high pressure vessels has been attempted by forming new capillary anastomoses and by the providing of large new channels. The capillary method is typified by omentopexy. Though results of this therapy in 1909 were encouraging in that 30 per cent were reported cured, 20 per cent relieved in a very large series of cases we now know that this procedure is without benefit.[30] More recent figures show for example that one-third of 227 patients with omentopexies died within the first month postoperative, and in another series of cases 77 per cent of cases died within the first year following omentopexy and other operations.[31] The criticism may be raised that the patients were very poor risks and that omentopexy is only tried as a last resort. The answer to this is that in any series of surgical cases for cirrhosis

the patients are at best poor operative risks. Not only is there a high immediate mortality but there are not enough long surviving patients to indicate the average prognosis of patients with cirrhosis is materially affected by omentopexy. Omentopexy has been performed for portal hypertension secondary to cirrhosis and secondary to extrahepatic causes. There has been no decisive beneficial effect when the operation has been performed for the extrahepatic group, though the operative and immediate mortality has been lower than in those cases of cirrhosis due certainly to the better general condition of these patients.

A recent therapy advocated along this same principle is that of posterior mediastinotomy. Garlock[32] reasons that irritation from packing of the posterior mediastinotomy promotes granulation tissue which will form a new vascular network between the submucosal and periesophageal veins of the esophagus and the deeper channels of the mediastinum, hence eventually to the azygos veins. Only 2 cases are reported and the follow-up in 1 case is for six years without bleeding and the second case is well with one episode of bleeding in 16 months postoperatively. The cervical approach to the posterior mediastinum was used in 1 case and the packing placed down to the arch of the aorta only. It does not seem that this therapy is properly located since the bleeding varices are so frequently in the lower third of the esophagus. In addition, this therapy is subject to the criticism as that of omentopexy, of forming channels too small to be of much value.

The shunting of blood by forming of large new channels would seem to offer more promise. This is accomplished by the anastomosis of a large branch of the portal system (usually the splenic vein, less frequently the portal and rarely the ovarian or mesenteric) to the caval circulation, the renal vein or the vena cava. Eck (1877) was the first to suggest anastomosis of the portal vein to the vena cava, but it has not been until the last few years that more than sporadic reports have appeared in the literature. Reports have come primarily from Blakemore[33] in New York. Cases which have ascites or a tendency to hemorrhage due to inability of the liver to form albumin or prothrombin in adequate amounts are not suitable for surgery. Other cases having varying degrees of depressed liver function plus evidence of considerable elevation of portal pressure have surgery indicated only when liver function is brought to its maximum. Surgery is primarily indicated in cases in which liver function is adequate but there is a severe degree of portal hypertension. Of 23 cases in which a shunt was performed, there were 4 postoperative deaths, 1 due to hemorrhage, 2 due to liver failure, and 1 due to mesenteric thrombosis. (Other cases were ex-

plored in which it was not feasible to do a shunt.) Seventeen of 19
surviving have a follow-up exceeding six months. One death was due
to uremia in a child with portal cirrhosis in which the shunt had
become occluded. One man with a bad portal cirrhosis died of
cholemia one year postoperative, the shunt remaining open.

Of the surviving cases, 5 with bad cirrhosis have done satisfac-
torily. All are active, 4 are working. There was delay in disap-
pearance in ascites in 1, a minor bleeding episode in another. All 5
were followed one and one half to two years.

One case had 3 episodes of bleeding and it was thought that the
anastomosis did not shunt enough blood for relief. Five other cases
had one or more episodes of bleeding postoperatively. They felt that
in 3 cases the evidence pointed to closure of the anastomosis and
that 3 others did not have a shunt of sufficient size to shunt an
adequate amount of blood to afford absolute protection against
future hemorrhage. Fifteen of these patients had had a splenorenal
shunt following splenectomy and nephrectomy, one had stump of
splenic vein to renal vein and seven had side to side portacaval
anastomosis. In September, 1948, Blakemore stated that now 36
cases had been performed with 5 postoperative deaths. In his last
13 cases he has had one operative death.

The other report of a large series of cases is by Linton.[34] Of 7
cases of cirrhosis of the liver, 1 is living 29 months and 1 living
one year without further bleeding. However, 5 of the 7 operative
cases died postoperatively, a mortality of 71 per cent. These 5 were
all poor operative risks and in some anastomosis was difficult be-
cause of cavernomatous tissue at the portal vein. Of the extra-
hepatic group 7 are living and well without bleeding from periods
ranging 5 months to 22 months. One patient bled postoperatively
and it is thought this is due to closure of the anastomosis which was
not expected to benefit the patient greatly since it was inferior
mesenteric vein to adrenal vein. It is interesting to note that 1
patient had had 18 bleeding episodes in 13 years before having
shunt operation done. He had bled despite injection of varices,
omentopexy, ligations of veins much earlier in life. Following this
earlier operation he had gone four and one half years in good health
without bleeding before he again began to have bouts of hemate-
mesis. In this patient, then, one must be extremely cautious in evalu-
ating the shunt operation since splenectomy and ligation of veins
gave all appearances of success for four and one half years.

In regard to operative procedures, certain points in operative
technique and practice are beginning to be more favored than others.
Preservation of the kidney is recommended in splenorenal shunts.

The splenorenal shunt is sometimes preferable to portacaval shunt because the liver is not completely bypassed; the left upper quadrant field of operation has fewer vital structures which might be injured accidentally; there is less likelihood for encountering hemorrhage especially from cavernomatous transformation and there is some benefit from splenectomy itself. The portacaval shunt is preferred because of the larger channel created; the preservation and lack of interference with the kidney; and a complete diversion of flow from the liver may be avoided by a side to side anastomosis: that is, the use of the Blakemore vein-lined vitallium tube is not being used as frequently as when first introduced, but instead the simple silk suture anastomosis is being used more.[35] Heparin has been used in some cases, but usually not. Blakemore has recently readvocated the use of anticoagulants.

Surgical procedure for ascites:

For the treatment or control of ascites as separated from the other pressing problems of cirrhosis, many surgical procedures have been devised. Paracentesis is the simplest in performance, very low risk, but is disadvantageous on account of the continued loss of body protein. Some have practiced the reinjection of ascitic fluid intravenously.

Ferguson[36] anastomosed the renal pelvis to the peritoneum in order to drain ascitic fluid from the abdomen. This also allowed continued loss of protein. A further disadvantage was the renal pelvis becoming blocked by omentum. Another procedure is the anastomosing of the saphenous vein to the peritoneum. The valves of the saphenous were expected to allow the passage of the ascitic fluid into the caval venous system, but not to allow the venous blood to pass into the abdominal cavity. From lack of personal experience and published reports, these procedures cannot be properly evaluated.

A surgical procedure which has persisted is the placement of a glass button, connecting the peritoneal cavity to the subcutaneous tissue. The fluid is then absorbed into the caval venous system, via the capillaries of the anterior abdominal wall. Lord's[37] modification of this involves the removal of a portion of fascia of the anterior rectus sheath in this area so that fluid will be absorbed better and so that the fluid has less chance of pocketing off as it frequently does. The other difficulty encountered is the plugging of the button by omentum. These two objections to this procedure leave it far from efficient.

By the reduction of portal venous pressure by a shunt operation

the tendency to ascites should become less. This has been found to be true in the small series of cases performed.

CONCLUSIONS

A proper evaluation of treatment of portal hypertension must be based on the differences between intra and extrahepatic causes and their resultant differences in pathology and clinical course.

Extrahepatic obstruction after its differentiation from intra-hepatic obstruction by clinical findings and history and laboratory studies demands treatment. Until the results of splenorenal and portacaval shunts have been observed for a period of 10 years or more it is unsafe to advise these procedures too strongly regardless of the rational and physiological appeal they possess. It may be in time that the results will be no better than other surgical therapy and the risk of this longer, more complicated and technically difficult operation would not be warranted. Whether or not a shunt procedure is performed, splenectomy is indicated for relief of the splenic tumor, the thrombocytopenia, the leukopenia and anemia. If the patient with extrahepatic obstruction has already been splenectomized and still continues to have bleeding episodes, either injection therapy of the varices should be considered or possibly a shunt procedure may be attempted. The splenic vein no longer being usable following a previous splenectomy, a portacaval anastomosis is indicated, but the success of this will depend partly on the location of the obstructing lesion, so frequently undetermined at operation. If, following splenorenal anastomosis, then the episodes of bleeding are not controlled and the patient does not enjoy good health without daily fear of disastrous hemorrhage, injection of esophageal varices with sclerosing solution should be carried out. The value of intraesophageal tamponade is great and is the method of choice in controlling the acute episode of bleeding, either in preparation for direct surgical therapy or as an additional treatment if the direct attack of splenectomy and splenorenal shunt is unsuccessful. Esophagogastric resection, as Phemister believes, should only be resorted to when all these other measures have failed.

Intrahepatic causes of portal hypertension differ in that indications for treatment because of the additional factor of ascites, the older age and poorer general condition of the patient, and most of all the hepatic insufficiency. Again the procedure of greatest physiologic appeal is the portacaval shunt, of which only further longer observation will completely assess. Certainly splenectomy alone, and the extensive gastroesophageal resections would not seem indicated giving too little in return for the large risk involved. Tam-

ponade and injection of varices has an even more preferred place in these patients because of the factors mentioned above. These conservative measures should certainly be called upon in the acute episode of bleeding. Their value in the very poor surgical risk patient and in the cases where other therapy has failed is also high. In the selection of a shunt operation, the preference lies toward a side-to-side anastomosis of the portal vein to the vena cava. For aid in the control of ascites, the glass button technique is advised despite its inadequacies.

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RECENT ADVANCES IN THE TREATMENT OF PERIPHERAL VASCULAR DISEASES

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IT IS gratifying to see the increased interest and, consequently, the remarkable advances in the treatment of peripheral vascular diseases during the last few years. Not too long ago patients with disorders of peripheral circulation were prone to visit many doctors without obtaining much satisfactory treatment. Much credit for awakening the medical profession to increased interest and better treatment of these patients must be given to Homans' Ochsner, and deTakats, who have done much to popularize and extend the modern approach to these problems.

New drugs and technics are being advanced with regularity and varying success. These are primarily aimed at the sympathetic nervous system or at the clotting mechanism of the blood. Tetra-ethyl-ammonium compounds as well as priscol have been added to the armamentarium as effective conservative measures in treating certain peripheral vascular conditions.[1,2] Dibenamine is a strong adrenolytic and sympatholytic agent which has great potentialities. However, more work needs to be done on this drug.[27] Heparin has been in use for a long time in preventing intravascular clotting and the extension of such clotting after it has formed. Its use has been effectively widened by the development of the Pitkin menstruum which can be administered intramuscularly. Dicumarol is easier administered for a similar effect and may be given in conjunction with heparin. Recently Selecman and Miller have reported apparent relief from thrombophlebitis migrans by the use of antihistamine therapy.[3] Glycine as a vasodilating agent has had some success.[4] Radioactive sodium has been used in determining the amount of effective circulation in the extremities in various types of vascular disorders. It promises to give at least information as to the most favorable site for amputation, as well as a test of the effectiveness of various types of therapy.[5,6,7]

Admittedly conservative or medical management fails to cure a great proportion of the disorders of the peripheral circulation. As our knowledge of the physiology and pathology of peripheral vascular diseases has advanced, surgical technics have been advanced and widened in their effectiveness. One reason the tetraethyl-ammonium and other vasodilators are far less effective for a localized peripheral vascular problem in one limb is the "borrowing-lending" hemodynamic phenomenon (hemometakinesia) proven by plethysmography.[8] There is a shifting back and forth of blood from

one part of the body to another, permitting the body to utilize its limited total blood volume in the most efficient manner. Therefore, the most effective method of increasing the local blood supply is sympathetic denervation of the affected part. This fails to rob vital organs of essential blood supply, hence the borrowing-lending mechanism does not come into full play, and the local blood vessels are dilated to their fullest extent.

ARTERIAL INSUFFICIENCY

Buerger's disease or thromboangiitis obliterans is primarily a disease of young men who smoke, and usually first starts in the legs. However, it may be seen in women and may localize in any part of the vascular system including cerebral, cardiac, renal and mesenteric vessels, and no age or race is immune.[9] This is usually a segmental inflammatory process of both veins and arteries progressively shutting off the arterial blood supply to the extremities. Usually this is evidenced by the history of progressive intermittent claudication. The patient finds he can walk shorter and shorter distances without severe pains in his legs or feet. Finally, there is pain at rest, and there are the typical findings of blanching on elevation, rubor on dependency, with pulseless, cold, clammy feet. If therapy is not instituted at once, painful persistent ulcers or gangrene may quickly follow, many times resulting in amputation.

The early cases of thromboangiitis obliterans respond very well to conservative treatment consisting of abstinence from tobacco, Buerger's exercises, meticulous care of the feet with avoidance of extremes of heat and cold. Moderate amounts of alcohol are advised daily and the patients are given priscoline 25 mg. three or four times a day. Usually under such care the early cases of Buerger's disease are able to develop enough collateral circulation, and the vascular spasm is relieved to such an extent that the progressive symptoms of the disease are reversed, sometimes for long periods of time.

If such therapy fails, or if there are signs of impending gangrene or intractable pain, one must consider lumbar sympathectomy. This should be done before too much permanent damage has been done to the arterial tree. Results are often dramatic. Many patients are saved from gangrene and are rehabilitated by this procedure. Sympathetic denervation remains the main type of definitive treatment for this disease. A preoperative sympathetic nerve block may be done to estimate the benefit from the operation. However, the lack of demonstrable improvement in circulation during such transient sympathetic anesthesia does not always indicate that no improve-

ment will follow sympathectomy.[10] Because the operation does not cure the underlying disease process in the vessels, it is very important that these patients continue to avoid tobacco. In those patients that have painful ulcerations, it may be advantageous to crush the sensory nerve to the ulcer, which allows it to yield much more readily to treatment.

Arteriosclerosis is the most common cause of arterial insufficiency in the lower extremities. The end results and many of the symptoms are similar to that of Buerger's disease. There is incapacity due to claudication and pain in the legs, even at rest, going on to the development of gangrene, and possible amputation. In the milder cases the vasodilating drugs such as priscoline and tetraethyl-ammonium chloride combined with abstinence from tobacco, meticulous care of the feet, Buerger's exercises and moderate amounts of alcohol are beneficial. As in any patient with arterial insufficiency, hot applications must be avoided, because the increased local metabolism combined with the inability of the arteries to supply the needed blood may actually precipitate gangrene. Selected cases of arterial insufficiency due to peripheral sclerosis have been rehabilitated and have been prevented from developing gangrene by lumbar sympathectomy. Many more of these cases have been reported in the literature recently than formerly.[11,12]

There are several other vasospastic disorders of the peripheral arteries that are very disagreeable and sometimes quite disabling. Many of these respond to conservative therapy but occasionally require sympathetic denervation. Reynaud's disease, primarily a disease of younger women with symptoms almost confined to the hands, may produce painful ulcerations of the fingers or even gangrene. Permanent release of vasoconstriction through dorsal sympathectomy may be the only relief available. Results are better before the development of permanent irreversible changes such as scleroderma or gangrene. Excellent results are also reported in the treatment of acrocyanosis and hyperhidrosis by sympathectomy.[10,26] Causalgia may follow a simple fracture or other relatively slight injury usually causing swelling, pain, and tenderness that does not respond to physical therapy. Hypersensitivity even to light stroke or a draft of air may be present. There is evidence of vasospasm with a cold, clammy extremity. Some beneficial effects from the administration of tetraethyl-ammonium have been reported.[1] However, in our hands this type of therapy has not been very beneficial. Sympathetic nerve blocks with 1 per cent novocaine have cured most of our patients. Nevertheless, some have required sympathectomy, usually the ones who have delayed treatment.

Arterial embolism in an extremity is an acute surgical emergency and must be operated on at once if the patient's condition will permit and the clot is large enough to cause arterial insufficiency in the limb. There is no mistaking the diagnosis. The patient usually has the history of recent myocardial infarct or auricular fibrillation. There is a sudden shooting pain in the extremity with gradual increasing numbness and cooling with final inability to move the limb. There is found coldness, mottled cyanosis, collapse of superficial veins and loss of peripheral pulses. The earlier embolectomy is done the better the results are. The patient should be operated on within twelve hours before the smaller vessels are thrombosed. However, some successful operations have been reported even after 24 hours.[10] After the position of the embolus has been determined the artery is exposed, whether in the arm, leg, or at the bifurcation of the aorta. The artery is opened with a tape under the upper and lower segment of the artery to control bleeding by simply pulling on the tape. The clot is suctioned out the vessel and the vessel is sutured with fine arterial silk. A thrombin soaked piece of gelfoam is placed over the suture line to prevent any ooze. Anticoagulant therapy is extremely important to prevent thrombosis. Three hundred mg. of heparin in Pitkin menstruum is given immediately along with 300 mg. of dicumarol by mouth. Although doses may be altered for individual cases according to prothrombin levels, 200 mg. of dicumarol is given the second day and 100 mg. daily if the prothrombin time is kept less than one minute. Old patients with liver disease must be watched very carefully on dicumarol, and heparin may be used exclusively in these patients.[13] It may be to advantage to do sympathetic nerve block with novocaine following embolectomy, and this combined with anticoagulant therapy may be all that is required for the small emboli in the distal branches of the main arteries.

Arteriovenous fistulae are most always due to trauma, but may be due to congenital defects. Due to the short circuit of blood flow the extremity receives insufficient blood supply and the heart may be seriously affected due to the increased load. Operation is imperative and in many cases the continuity of the artery may be preserved by ligation and transfixion of the fistula or by lateral arteriorrhaphy. Sometimes it is necessary to do an end to end anastomosis or establish the arterial continuity by a venous graft.[14] Anticoagulant therapy should be used in most of these cases, and in many sympathetic nerve blocks are found useful, but sometimes sympathectomy is necessary. Somewhat similar procedures are sometimes indicated for peripheral arterial aneurisms.

VENOUS INSUFFICIENCY

Varicose veins are ones which have lost their power to transmit blood toward the heart against gravity, usually being dilated, tortuous and fibrosed, the valves being destroyed. When the body is erect, blood actually flows down them in the reverse direction, and must be carried off by deeper and more competent veins. The local nutrition is so bad that frequently swelling of the extremity and indolent varicose ulcers are the result. Unfortunately, there is some difference of opinion as to the best treatment of this condition. For years the popular method of treatment was injection therapy alone. However, since deTakats[15] first reported the combined saphenous ligation and injection treatment results have greatly improved, particularly with certain modifications.[16] In doing the ligation the importance of individually ligating all five of the superficial branches must be stressed. This cannot be done if the incision is too low. We have found the easiest approach to be through an incision in the crease of the groin over the femoral pulsation. An attempt to revive the old operation of phlebectomy or vein stripping has been tried by some,[17,20] but in the opinion of the author, the same reasons for abandoning it years ago are still present.

Venous thrombosis has long been a distressing problem and today there is some divergence of views on the subject. Treatment that has been proposed ranges from the use of anticoagulants alone[18,21] to ligation of the inferior vena cava.[19] In dealing with this serious condition we agree with Ochsner[22] and Homans[23] that it is imperative to differentiate between the two types of venous thrombosis, the thrombophlebitis which is associated with inflammation in the vein wall, and phlebothrombosis which is not the result of inflammation, and because the clot is not firmly attached, it is the one that is very likely to produce fatal emboli. The symptoms and pathology are quite different in the two conditions.[22] In femoroiliac thrombophlebitis there is pain and fever, with swelling of the leg, which is white and cold. Although the symptoms are severe, they can be controlled by sympathetic nerve blocks which also prevents disagreeable sequelae which otherwise might persist for years. Ochsner advocates active mobilization with compression bandages as soon as the fever subsides. Others use anticoagulant therapy with the sympathetic nerve blocks.

Phlebothrombosis is harder to diagnose because of the little reaction in the vein.[24] The first indication may be a nonfatal pulmonary embolus. However, it can be picked up by careful watching the extremities when patients are in bed. The pulse rate may be slightly elevated. There is tenderness over the femoral vein and a

positive Homans' sign. Slight swelling may or may not be present. Although we do not believe venous ligation is necessary in the uncomplicated case of thrombophlebitis, we do believe all cases of phlebothrombosis and suppurative thrombophlebitis must have ligation of the veins above the disease process. Homans[25] states that postoperative swelling and lameness in the calf is more likely to follow common femoral ligation than any other procedure. Therefore, it would seem logical to ligate the veins at a higher level. Certainly in those that have involvement in both legs, vena caval ligation, as suggested by Thebaut and Ward, is desirable which leaves little in the way of postoperative sequelae.[19] In those with unilateral involvement phlebotomy and ligation of the external or common iliac vein has been satisfactory. Anticoagulant therapy is given after such ligations.

Postphlebitic swelling and ulceration are often found due to varicosities and incompetent femoral veins due to scarring of the valves and recanalization. Such a state of affairs results in venous stasis. These patients are greatly improved by superficial femoral vein ligation (distal to the profunda femoris) and obliteration of the existing superficial varices.[26,10] Some of these patients respond to sympathetic denervation when more conservative measures are of no avail.

Summary

1. In the last few years there has been much more interest in peripheral vascular diseases, and consequently many advances in our treatment of these disorders have been made.

2. Although there are several drugs on the market with good vasodilatory properties, their effect for a localized condition in one limb is limited by the mechanism of hemometakinesia in which blood is shifted from one part of the body to the other to conserve effective blood volume.

3. Sympathetic denervation remains the most effective method of relief for most patients with arterial insufficiency.

4. Ligation of the vein above the thrombus is advocated for all cases of phlebothrombosis and suppurative thrombophlebitis along with anticoagulant therapy.

5. Ligation is not advocated for thrombophlebitis (phlegmasia alba dolens). These patients respond to sympathetic nerve blocks, and because the clot is firmly fixed, are not subject to fatal pulmonary embolism.

6. Postphlebetic swelling and disability may be greatly helped by

obliteration of the superficial varicosities and incompetent canalized femoral vein.

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SELF-EXAMINATION OF THE BREASTS

Treatment of cancer of the breast has become fairly well standardized and the salvage rate has not improved appreciably in the past two decades. It is generally agreed that, until some different approach to the problem is introduced, further improvement must necessarily depend upon earlier detection. It is impractical for the average woman to present herself for examination by her physician oftener than once or twice a year. Certain rapidly growing tumors of the breast may progress from the stage of earliest possible detection to an incurable stage within three months or less. Periodic examination of the breasts by the patient herself would seem to be the practical answer to the need for more frequent examination.

It has been demonstrated that often the patient can detect a small lump that escapes detection by the examining physician until his attention is called to it. When the patient discovers an abnormal condition in her breast, she should report it to the physician without delay. Once this is done, the responsibility comes to rest upon the physician and any delay in institution of the proper course of procedure constitutes negligence. With early detection by the patient, prompt consultation, and immediate institution of proper treatment, the patient is given her best chance for cure.

A number of popular lay publications have recently presented articles advocating regular self-examination of the breasts. An excellent moving picture on this subject will soon be released to women's clubs and other organizations. Many physicians are routinely instructing their women patients in the proper technic of self-examination of the breasts. It must be emphasized that such examination does not in any way replace periodic examination by the woman's personal physician.

To be effective, self-examination must be as thorough and comprehensive as the physician's examination. It must be conducted regularly. Monthly examination is usually advocated, and a time midway between the periods is probably best. The woman first observes her breasts while standing before a mirror in a good light. The shape of each breast is observed from the front and in profile, first while standing erect, next while leaning forward with the breasts pendant and then with the arms raised over the head. The two breasts are compared in size and shape. The nipples are gently milked and observed for secretion. The breasts are carefully palpated "around the clock" while standing erect and while lying supine. The right hand is used to palpate the left breast and vice versa. Finally the axillae and supraclavicular fossae are palpated. Any change in shape or size of the breasts, any mass or thickening and any secretion of the nipple should be reported to the physician without delay.

In order to prevent undue concern and preoccupation on the patient's part, it is necessary to inform her that every breast lump is not a cancer and that, in event a lump is discovered, there are two chances in three that it is not malignant. Most women are very cooperative in carrying out this program. The occasional disinterested patient will become sufficiently concerned to adopt the program after she learns that a combination of early detection and prompt treatment would, in event she did develop a cancer of the breast, increase her chances for cure from about 2 in 10 to about 7 in 10.

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BOOK REVIEWS

Techniques in British Surgery. By Rodney Meingot, F.B.C.S. Philadelphia, Penn.: W. B. Saunders Co., 1950. 733 pages. Price, $15.00.

This is a volume which consists of a number of specially selected articles on surgical subjects written by twenty-nine of the leading surgeons of the British Isles. This should represent a liberal cross section of British surgery as practiced today. As intimated in the previous sentence, only certain selected subjects are included. These are, however, in general done rather thoroughly. There is a brief discussion of the disease followed by a discussion of the type of anesthesia used. The operative procedure is described in detail. The volume is fairly well illustrated, the drawings being typically British.

The book is divided into four parts, the first dealing with certain conditions of the head, the neck, and spinal column. Part two deals with conditions of the thorax; part three, diseases of the abdomen and pelvis, and part four, the conditions of the extremities.

Outstanding among the omissions are the diseases of the biliary tract, and also conditions of the colon. Considerable time is spent on such subjects as thymectomy for myasthenia gravis, as well as congenital defects of the heart.

This is a very interesting volume and brings to light many "tricks of the trade," which are not too often seen in American surgery. It is a book which should be welcomed on the library shelf of more progressive and advanced surgeons. The printing is small, but quite readable. The photographs are very well done. The paper and binding are excellent.

A. H. Letton, M.D.

Diagnosis and Treatment of Tumors of the Head and Neck (Not Including the Central Nervous System). By Grant E. Ward, M.D., F.A.C.S., and James W. Hendriks, M.D. Baltimore, Md.: The Williams and Wilkins Co., 1950. 832 pages. $15.00.

This is an excellent volume, written by the founder of the Tumor Clinic of Johns Hopkins Hospital and his associate. This volume is packed with practical information regarding the diagnosis and treatment of tumors of the head and neck, and is written entirely for the clinician, whether he is a specialist or a general practitioner. Throughout the volume early diagnosis is stressed and the evaluation of treatment from the viewpoint of the surgeon and radiologist is discussed, and both methods of treatment are compared. Embryology and pathology are stressed as a basis of diagnosis and treatment.

The writing is very good, the style being entirely scientific but readable. The authors are to be complimented on their illustrations. The drawings are good. The black and white pictures are very nice, while the colored photographs must be classified as excellent. Each type of tumor is well illustrated. Operative procedures are well outlined, both in text as well as drawings and pictures of operations.

This book should find its place in the library of all surgeons and should be welcomed by the general practitioner, for all too often the patient might have

been cured had the practitioner recognized the lesion early and instigated proper attention. Others, who should find this book quite helpful, are the plastic surgeons, the dental surgeon and the x-ray therapist.

A. H. LETTON, M.D.

CRANIOPLASTY. By DAVID L. REEVES, M.D., Santa Barbara, Calif. Springfield, Ill., U.S.A.: Charles C Thomas, Publisher, 1950. 132 pages. 71 illustrations. $3.00.

This is publication 39 of the American Lecture Series and is a monograph in the American Lectures on Surgery, edited by Michael E. DeBakey, M.D., and G. Glen Spurling, M.D.

There were many cranial defects consequent to the casualties of the past war, which has stimulated considerable interest in the problem of cranioplasty. The authors, in the historical review, show that cranioplasty was first devised by Fallopius in 1600 and they state that the techniques of plastic closure of the skull probably began with Seydel in 1889 (the editor recalls his grandfather telling of doing such a closure in the early 1880s near Cumberland Gap, Tenn.). Considerable space is devoted to a detailed discussion of the materials employed in cranioplasty, followed by operative procedures used. There is considerable space devoted to case reports with an excellent group of photos of the patients, as well as x-rays of the skull and illustrations of operative procedures.

This is an interesting monograph and lives up to the quality of the other publications of the American Lecture Series in Surgery.

A. H. LETTON, M.D.

THE BREASTS—STRUCTURE, FUNCTION, DISEASE. Edited by F. D. SANERMBCH (Camb.) F.R.C.S., Eng. Baltimore, Md.: The Williams and Wilkins Co., 1950. 316 pages. $8.50.

The author has combined the thoughts and writings of many of the leading surgeons of England in a compact little volume, the object of which is to present a picture of the structure, function, and disease of the breast and to include suggestions for treatment.

The subject-matter is quite well covered with a few minor exceptions. The writing for the most part is very nicely done and is quite well standardized. This standardization goes to such an extent that as one reads through the book he would hardly recognize that a different author is writing each chapter. Usually each disease is treated by several paragraphs under the headings of pathology, clinical aspects, and treatment. The printing and paper are very good. The regular photographs are very good. The black and white drawings are fair; the color drawings are rather unusual and not too well done; the color photographs are slightly inferior. Good color photographs would help immensely.

One very good chapter on the invasion of the internal mammary lymphatic chain by Dr. R. S. Handley is well worth reading. The chapter on radiotherapy covers 46 pages and seems rather thorough. A very good chapter on plastic contributions to surgery is included. The book ends with statistical data on breast cancer. This is a very worthwhile volume, which shows the great amount of knowledge that has been accumulated on the breast; but like-

wise helps to point out the many deficiencies in our knowledge of the breast. It should be a welcome addition to the general practitioner, the internist, as well as the surgeon.

A. H. LETTON, M.D.

PERSONALITY AND PEPTIC ULCER. By A. J. SULLIVAN, M.D., and T. E. MCKELL, M.D., Oschner Clinic, New Orleans. Springfield, Ill.: Published by Charles C Thomas. $3.00.

The authors have presented the ulcer problem in a most attractive and unique manner. This is a book that can be recommended not only to the professional but to the layman as well.

They have explained psychiatric theory of ulcer in terms that the layman can understand and also have gone into the various theories of the causes of ulcers and show very clearly that no one etiological factor can explain all ulcers or the recurrence of ulcers.

To explain this they have devised an equation or formula in which many factors play a part. Among these are the constitutional and genetic, the so-called ulcer personality which predisposes to the formation of ulcers or the intrinsic psychic factors, the acute precipitating emotional situations, trauma, which may be either internal or external, and then a group of various physiological factors which are unique in producing ulcer rather than cardiospasm, ulcerative colitis, asthma or some other psychosomatic affection.

Thus it is seen that it is a combination of one or more of these factors which forms the numerator of the equation and the denominator is the resistance of the mucosa to ulceration. The resistance and the ulcer are given the value of one and the others, any value less than one so that when the equation totals more than one, the patient is likely to develop an ulcer. On this basis they can explain recurrent ulcers, ulcers occurring in people who otherwise have been perfectly healthy with no ulcer history, ulcers occurring in patients who do not have the so-called ulcer personality and so on.

They have reviewed a large series of ulcer histories but have studied in detail 200 cases and these they place in four groups. The largest of these (72 per cent) consisted of patients with the typical "ulcer personality." The second, consisting of 11 per cent, were definitely psychoneurotic. The third (5 per cent) show some striking external precipitating situation and in 10 per cent there were no extrinsic or intrinsic psychic factors but some unusual degrees of one or more of the other factors.

The ulcer personality receives detailed attention and this chapter is made all the more attractive by illustrations by Dr. Frederick C. Rehfeldt and Mr. Harry de Vore.

The treatment of ulcer is only touched in a superficial way since this treatise is not supposed to cover that part of the ulcer problem. The chief point that they make in this chapter is that all ulcers should be properly classified and the same treatment cannot be used for every ulcer case. In those in which recurrences are likely to be found, the patients are cautioned as to their habits, including diet, and are thereby able to prevent recurrences.

This book contains only 92 pages of text and presents very interesting reading, as stated, not only for the doctor but for his more intelligent patients. It might well be placed on the reception room table. Certainly any doctor, either a surgeon or internist, will profit by reading it.

WM. P. NICOLSON, M.D.

ABSTRACTS FROM CURRENT LITERATURE

PROGRESSIVE ULCERATION OF THE ABDOMINAL WALL—AMOEBIASIS CUTIS. Oscar B. Hunter. *Mississippi Valley Medical Journal* 72:89-92 (July) 1950.

Progressive ulceration and gangrene of the skin of the abdominal wall following appendectomy, first described by Cullen in 1924, continues to be a serious problem. Up to the time of this report, 32 cases have been reported in the literature. Though the exact pathogenesis is still debated, the lesion is probably identical with the disease that dermatologists refer to as pyoderma gangrenosa and amoebiasis cutis. The older idea of bacterial symbiosis is crumbling in the increased frequency with which endamoeba histolytica is found in scrapings and biopsies of the edges of these lesions. Untreated, the lesion may spread to involve the entire abdominal wall often with fatal results and any progressive ulceration of the skin following operation should be regarded with suspicion. Early antibiotic and amebicidal therapy combined with complete resection of the involved area with cautery is the best mode of treatment.

<div align="right">R. H. S.</div>

SEGMENTAL RESECTION OF THE ESOPHAGUS IN INFANTS. Report of Two Cases. Champ Lyons, Alton Ochsner, and Ralph V. Platou. *Southern Medical Journal* 43:585-589 (July) 1950.

Rapid progress in pediatric and esophageal surgery has prompted the authors to seek surgical correction in an increasing number of instances of esophageal obstruction in infants. They feel that a sharp distinction must be made between strictures following corrosive esophagitis and obstruction due to congenital anomalies. The former group with proper early treatment and adequate bougienage according to the Bokay routine will usually not require resection and when they do, cervical esophagogastrostomy is usually necessary since the constricted segment is usually extensive. In the latter group the obstruction is usually due to a web or a short stricture. These lesions lend themselves to segmental resection and anastomosis. Perhaps the commonest type is a mid-thoracic stricture associated with a short esophagus.

Two cases are presented. The comment on these cases is quoted:

"An infant eight months of age was referred for treatment of a midthoracic stricture in association with a congenitally short esophagus. Segmental resection of the stenotic area was performed without gastrostomy. The dilated esophageal segment required three months to return to normal size. The diet was restricted to liquid and semiliquid foods throughout this period and has only recently been increased to include more solid foods. The patient is now doing well. - - -

"Complete obstruction developed during the first month of life in an infant with a congenital esophageal web and proximal megaesophagus. Esophagotomy with excision of the web relieved the obstruction but dilatation of the proximal esophageal segment persisted in the immediate postoperative period. Attempts to feed solid food before this dilatation subsided precipitated obstruction even to the passage of liquids. Bougienage relieved this obstruction, but it recurred when solid foods were again added to the diet. Further esophagoscopic manipulation, without evidence of injury to the esophagus, was followed by signs of esophagitis and periesophagitis. We believe that this was an exacerbation of

latentesophagitis. Gastrostomy at this time permitted cessation of oral feedings. During the next ten months the condition of the esophagus returned to normal with disappearance of the megaesophagus and apparent stricture. Dilatations were not done during this period. An adequate diet is now taken well."

The writers feel that gastrostomy will be required more often than not but need not be done routinely. It was not necessary in one of their cases. In the other, the complete satiation of the child by overfeeding via the gastrostomy almost led the authors to interpret the child's refusal of food and liquids a symptom of obstruction when an adequate lumen was present.

Persistence of obstruction due to localized esophagitis may persist for three months and motor dysfunction of the upper segment frequently persists from six to eighteen months.

A plea is made for investigation of this overall problem and especially for correlated anatomic and physiologic studies of the motor function of the congenitally abnormal esophagus.

Though prolonged follow-up studies will be necessary before final evaluation, the authors feel that segmental resection for localized constrictions of the esophagus is a feasible procedure and is preferable to programs requiring prolonged bougienage.

R. H. S.

AINHUM (DACTYLOLYSIS SPONTANEA). Denham C. Hucherson. *Annals of Surgery 132*:312-314 (August) 1950.

Ainhum, a condition which always occurs in the fifth toe of negroes and is characterized by a constricting band of fibrous tissue which gradually encircles the toe, deepens and finally strangulates the underlying structures producing spontaneous amputation, was first described as an entity in 1860. Since that time many theories regarding its origin have been advanced, none of which has proved satisfactory and the cause is still unknown. No characteristic microscopic changes have been observed and, unless there be secondary infection, evidences of inflammatory reaction are absent.

This report reviews ten cases of which the author has been able to review the records. All of thees cases were seen in his locality (Texas). The fifth toe was involved in all cases and in one case the condition occurred bilaterally. There were eight males and two females in this series. All patients were either in the fourth, fifth, or sixth decade. In every instance extreme pain was suffered in the later stages. A history of trauma associated with the onset of the process was always elicited but such histories were vague and no importance could be attached to them. No familial tendency was noted. Every case became infected at some time during the course and infection increased the pain. In every case the toe was amputated with complete relief of symptoms.

R. H. S.

ANURIA AND THE SURGEON. A. M. Joekes. *British Journal of Urology 22*:125-131 (June) 1950.

Emphasizing that the term anuria signifies renal failure and that no diagnostic or prognostic importance can be attached to oliguria as opposed to anuria, the author interprets the term as acute renal failure supervening on previously healthy kidneys. In a discussion of the etiology, he follows the

classification of Fishberg; 1) prerenal, 2) postrenal, 3) renal. This latter group is divided into three types; 1) acute glomerular nephritis, 2) bilateral cortical necrosis, and 3) acute tubular nephrosis. This latter group is the commonest cause of acute failure and is the most important because, theoretically, the renal lesion may recover in every case. This group is further subdivided as follows:

1) Acute toxic nephrosis.

2) Lower nephron nephrosis.
   a) Intravascular hemolysis.
       Incompatible transfusion.
       Water hemolysis, e.g. postprostatectomy.
       Hemolytic infections.
       Hemolytic poisons.
       Burns.
       Crush syndrome.
       Abortion.
   b) Shock.
   c) Sulfonamide sensitivity.

The diagnosis of lower nephron nephrosis may be made in acute renal failure only upon eliciting the history of one or more of the predisposing causes. There are no peculiar physical signs. It is emphasized that a low specific gravity with oliguria is just as indicative of renal damage as is anuria.

In a discussion of the treatment, the author considers briefly the various applications of dialysis and various surgical methods attempting to restore kidney function. "Recent work suggests that, in the large majority of patients with anuria, correct dietetic management will allow renal function to recover and the patient to survive." After postrenal obstruction be excluded and any existing hypertension corrected, attempts should be made to correct the cause. In intravascular hemolysis, copious diuresis should be maintained (using sodium sulphite). At no time should the administration of fluids by all routes be more than 1 litre ahead of the urine output. In mercury poisoning, BAL should be administered.

As soon as oliguria is recognized, a mixture of glucose and arachis oil emulsified in water by acacia is given by slow drip through an indwelling gastric tube. Urine output is replaced with water plus one litre per 24 hours. Any vomitus collected is filtered and returned to the stomach by way of the tube. Once the diuresis exceeds 1 liter in 24 hours, the tube is removed and the patient is fed a high caloric, low protein diet by mouth. This usually occurs between the 8th and 14th days after the onset.

An illustrative case is included. The author concludes that the conservative treatment has produced such satisfactory results, other measures may be judged only in relation to this management.

R. H. S.

THE ROLE OF X-RAY THERAPY IN CARCINOMA OF THE BREAST. Harvery W. Stone and Halvor Vermund. *The Journal-Lancet 70*:247-249 (July) 1950.

The authors in this brief communication report the results of their treatments of operable carcinoma of the breast at University of Minnesota during the 1939-42 period with five year survival rates. Of a group of 40 Group I

cases given preoperative radiation (most of whom exhibited clinical evidence of local invasion), 28 cases or 70 per cent survived five years or longer. Of a group of 118 Group II cases, 46 or 39 per cent survived five years or longer. Of 209 operable cases of all types, 98 or 47 per cent survived five years or longer. It is emphasized that Haagensen's rules of operability were not adhered to.

The authors have drawn the following conclusions from their own material and recent publications in the literature:

1. Stage I cases of carcinoma of the breast: Breakdown into two groups.

a) Those with freely movable mass: The treatment of choice is radical mastectomy alone.

b) Those with evidence of extension beyond the primary mass, such as superficial or deep fixation; postoperative x-ray therapy should be used.

2. Stage II cases can be divided into two groups.

a) Those in which there is no clinical evidence of tumor extending beyond the capsule of the lymph nodes in the axilla; these could be treated by radical mastectomy and postoperative irradiation delivering a relatively large dose over a period of two to three weeks and given within two weeks after surgery.

b) Those in which there is clinical evidence of extension beyond the capsule of the lymph nodes. These should be given preoperative radiation therapy followed by immediate surgery and postoperative irradiation.

3. Inoperable and recurrent cases should be given radiation therapy as the treatment of choice with the exception of a few cases in which hormone therapy can be successfully applied.

R. H. S.

TREATMENT OF PAINFUL AMPUTATION STUMPS. W. Ritchie Russell and J. M. K. Spalding. *British Medical Journal 4670*:68-72 (July 8) 1950.

One of the authors (W.R.R.) first described treatment of painful neuromata in amputation stumps by repeated percussion in 1949. That report included seven cases. All of these are greatly improved. Most have lost all tendency for the pain to recur but some occasionally have twinges which are relieved by short periods of treatment. The purpose of the present report is to present the results achieved in further cases and to describe in greater detail the methods employed.

The authors have had 37 further cases under consideration but some of these had disabilities which rendered them unsuited to percussion therapy such as sciatica, spinal arthritis, hysteria, etc. One patient presented a cold, diffusely tender stump which responded to sympathetic nerve block. Thirty-three cases were treated by percussion. The results in these cases are presented in tabular form.

The self application of percussion is done either with a mallet and an applicator or, in case the site is beyond the patient's reach, by an electrical vibrator. The percussion is applied directly over the painful neuroma. If it is extremely tender, the arterial supply to the stump is occluded with a sphygmomanometer cuff until the anoxemia renders the neuroma less sensitive. After a few moments, percussion may be tolerated without constriction. Percussion is applied for 10 to 20 minutes three times a day until definite improvement has occurred, then once daily as needed.

Of 33 cases, 19 reported good or excellent results and 5 were improved. Only 1 failure was noted in the first 15 cases but in the last 18, some of which were especially difficult, there have been 8 failures.

Three illustrative case reports are included.

R. H. S.

GANGLIONEUROMA OF THE NODOSE GANGLION OF THE VAGUS. Richard C. Clay. *Annals of Surgery 132:*147-152 (July) 1950.

This tumor, which is relatively uncommon in any location, occurs rarely in the neck. The author has found only one previously reported instance of its arising from the vagus. He reports the following case in which the tumor was successfully resected:

A 2½ year old white female was admitted to the surgical service of the Johns Hopkins Hospital on December 4, 1948, because of a swelling in the left side of the neck. This had been discovered at the age of eight months and had persisted since that time with slight enlargement during the preceding few months. The mass was firm, nontender, very slightly movable and lay beneath the left sternocliedomastoid muscle. A striking feature was the anterior displacement of the carotid artery. The trachea was displaced slightly to the right. At operation, the tumor was found to lie within the carotid sheath and arose from the vagus nerve which for a short distance on the surface of the tumor, blended with the substance of the mass and could not be separated from it. There was little or no adherence to other structures within the sheath. The mass and the short segment of nerve were easily resected and the nerve ends were carefully approximated. No disturbance of the cardiorespiratory functions followed injection and section of the nerve but slight postoperative tachycardia persisted for four days. A left sided Horner's syndrome cleared up before discharge. The course was otherwise uneventful. A slight weakness of the trapezius has persisted and paralysis of the left vocal cord was still complete nine months postoperatively.

The tumor measured 8 cm. by 4 cm. and was a typical ganglioneuroma.

R. H. S.

MANAGEMENT OF PERIPHERAL NERVE INJURIES. Robert J. Murphy. *Southern Medical Journal 43:*627-631 (July) 1950.

"The treatment of peripheral nerve injuries is a complex problem requiring the coordinated cooperation of the physician in physical medicaine, the neurosurgeon, the orthopedist, the physical therapist and the occupational therapist. The program is usually a prolonged one, sometimes as long as eighteen to twenty-four months and the patient must be constantly supervised during the entire period."

In a two year period since the end of the war, 350 cases of peripheral nerve injury were seen at Walter Reed Hospital and since over 90 per cent of these were incurred in peacetime the author feels that the relative incidence, etc., in this series would correspond to those of such injuries seen in civilian practice. The purpose of this paper is to outline the program of management employed at this hospital.

Immediately following injury to a peripheral nerve, the muscles which lose

their function become hyperirritable. This occurs whether the nerve is repaired immediately or if repair is delayed and lasts from ten to fourteen days. During this period, nothing more than rest of the part and mild heat is employed. The following diagnostic measures are discussed briefly: Voluntary muscle check, sensory examination, circumferential measurements, Tinel's percussion test, cobalt chloride sweating test, Galvano-Faradic test and the Golseth-Fizzell electrodiagnostic test. These measures are employed routinely. When employed in determining progress, it is essential that the tests be performed by the same examiner at each determination.

During the period of regeneration, management is directed at the following objectives:

A) Maintenance of mobility.
    1) Carried out by the physical therapist.
    2) Motions carried out by the patient three times each day.

B) Prevention of deformities.
    1) Passive exercises.

C) Maintenance of muscle tone.
    1) Heat.
    2) Massage. (Not to be entrusted to patient or patient's family.)
    3) Electrical stimulation.
    4) Re-education.

Certain aspects of the situation other than primary or secondary suture of the nerve may be employed when continuity cannot be re-established by simple suture. Failure of regeneration may require joint fusion, tendon transplant, etc. Lastly, sympathectomy is frequently employed in treating the accompanying sympathetic disturbances. Then necessarily close relationship of the physical medicine service to the neurosurgeon and the orthopedist is emphasized.

R. H. S.

A CONTRIBUTION TO THE SURGICAL SIGNIFICANCE OF ABERRANT HEPATIC DUCTS. Vlad. Rapant and Jan Hromada. *Annals of Surgery 132:253-259* (August) 1950.

In the past, only practical knowledge of aberrant hepatic ducts concerned those occurring in the gallbladder fissure (the so-called ducts of Luschka) which, when opened during cholecystectomy, are the source of postoperative biliary drainage. The authors feel moved, with the increasing number of operations on the vagus nerve, gastric cardia, and lower esophagus, to draw attention to the existence of aberrant bile ducts in the fibrous appendix of the liver since this structure is usually severed to obtain exposure in such operations. Unintentional severance of this ducts without ligation might cause grave postoperative complications, not only from bile peritonitis but from contamination of the pleura and mediastinum with bile if the chest be opened.

The functional significance of these ducts is considered to be negligible if it exists at all. The presence of the ducts in some case would make it advisable to ligate the fibrous appendix before or after it is severed.

Two case reports are presented illustrating the occurrence of such ducts.

R. H. S.

DUODENAL FISTULA—PROBLEMS IN MANAGEMENT. Hollis L. Albright and Field C. Leonard. *Annals of Surgery 132*:49-63 (July) 1950.

The management and correction of duodenal fistula has remained a difficult problem and the mortality rate remains high. The authors quote Bartlett and Lowell who found a 37 per cent mortality in 128 patients and Colp who reported 51 per cent mortality in 61 cases. This communication emphasizes the management of acute, postoperative, external duodenal fistula, outlining a program which has been successful in their experience.

Duodenal fistula, being a high gastrointestinal outlet, rapidly depletes the organism. Massive fluid and electrolyte loss, deranged gastrointestinal mobility, and certain profound chemical changes in the bowel are seen. Up to seven liters of fluid containing as much as 2.5 grams of sodium chloride per liter may be lost even though nothing is taken by mouth. The untreated patient is besieged by starvation, alkalosis, dehydration, and uremia. The proteolytic enzymes spilling onto the abdominal wall produce the difficult complication of skin digestion. Though persistence of the fistula may be due to any cause that applies to the persistence of lower bowel fistula, it persists, in addition, because of the specific digestive action of the secretions passing through it.

Many ingenious methods have been devised to correct duodenal fistula. It has been pointed out that the method is no so important as the meticulousness of application. All methods have three aims: 1) prevention of tissue digestion by pancreatic enzymes, 2) maintenance of fluid, electrolytes, and nutrition, and 3) ultimate closure of the fistula and restoration of the continuity of the intestinal tract. Methods are both conservative and operative. They must be adapted to the individual case. A seriously depleted patient with marked digestion of the skin of the abdominal wall is not a suitable candidates for major surgical excision, shunting or exclusion procedures. Conservative measures must be employed for a time until his condition will permit surgery. The conservative measures may be curative within themselves.

Five case summaries with methods used in their management are presented and discussed.

The diagnosis must include thorough study to discover complicating factors, especially foreign body, obstruction, carcinoma or specific granulomatous disease. A program must be planned for the individual case. The patient should be placed on strict intake-output chart and to match the one for the other in daily fluid balancing allowing a positive balance of 1500 to 2000 c.c. Collected drainage is best refed when possible by distal jejunostomy. Daily blood chlorides should be followed and the chloride level maintained. Biweekly measurements of CO_2 combining power are sufficient if the chlorida level is fairly stable and the renal function good.

Protein loss and balance are more difficult to follow. One or two whole blood transfusions daily with additional use of parenteral protein hydrolysates and plasma according to hematocrit will usually maintain a positive protein balance. Calories provided by glucose are utilized for their protein sparing action. Adequate vitamin intake is of utmost importance.

Numerous methods have been devised for prevention of abdominal wall digestion:

1) Mechanical prevention of contact.

    a. Prone position on Bradford frame or divided mattress.

    b. Constant suction.

    c. Continuous bath.

    d. Insertion of mechanical occluding buttons.

2) Chemical neutralization (tannic acid, gelusil, kaolin, etc.).

3) Enzyme rivalry, whereby protein other than that of the patient's own body is provided to engage the activated trypsin.

In the authors' experience the use of amphojel paste and continuous suction (by the patient) have been most useful.

Duodenal fistulae may follow operations in the right upper quadrant, especially gastrectomy, gallbladder surgery, and difficult right nephrectomy. A distinction is made between the postgastrectomy duodenal stump "blow-out," giving the "end" type of duodenal fistula and the lateral type. The former is associated with about 14 per cent mortality and the latter with about 40 per cent mortality.

The authors conclude that major surgical procedures should be employed only after vigorous measures, with or without jejunostomy, have failed to maintain the nutritional state during the long period necessary for healing of the fistula.

<div align="right">R. H. S.</div>

MULTIPLE SUPERFICIAL EPITHELIOMATOSIS WITH SPECIAL REFERENCE TO TREATMENT WITH PODOPHYLLIN. Leslie M. Smith and H. D. Garrett. *Southern Medical Journal 43*:493-497 (June) 1950.

In support of their belief that podophyllin is the treatment of choice in this disease the authors offer this report of seven cases (one case of superficial squamous type lesions and six cases of basal type lesions) treated by this method with good results. The period of post-treatment observation varies from one to seventeen months. In some of the early cases in the series, it was apparent after healing that further treatment was necessary in certain areas. Recurrence indicates that the treatment has not been continued for a sufficiently long period of time. A distinct advantage of this treatment is that repeated treatment is not dangerous as in x-ray treatment.

The technic employed is as follows: Daily application of 20 per cent podophyllin in compound tincture of benzoin to all areas. After application, the areas are covered with dry gauze. This may be carried out at home but the patient should report every two or three days for removal of the necrotic material by curettage. Usually after three or four treatments, the lesions slough out sharply but treatment should be continued, seven to ten days usually being sufficient total time for treatment of superficial lesions. After discontinuing the podophyllin applications, the lesions may be dressed with any mild antiseptic ointment and, except in very large lesions, healing occurs in a few days.

The authors have been impressed with the usefulness and convenience of this method of dealing with multiple superficial epitheliomata. The healing time is short, and the scarring minimal. These advantages together with the good results obtained form the basis for their advancement of this method as the treatment of choice.

<div align="right">R. H. S.</div>

PLASMACYTOMA OF THE THYROID GLAND. Frank E. Barton and Douglas A. Farmer. *Annals of Surgery 132*:304-309 (August) 1950.

Extramedullary plasmocytomas usually occur in the upper respiratory tract or in the conjunctiva but several cases have been reported in which they occurred in other locations. Four plasmocytomas of the thyroid gland have been reported previously. The authors' case brings the total to five. This, in brief, is the case of a 77 year old white woman complaining of a swelling in the neck of ten months' duration and choking sensations of two months' duration. Two weeks prior to admission she became hoarse. There were no symptoms of thyrotoxicosis. She had had arthritis for many years which had become worse during the present illness. Positive physical findings included marked firm, nodular enlargement of the thyroid gland which was movable and non-tender. There was no cervical lymphadenopathy and no signs of toxicity. Laboratory studies were all within normal limits. The trachea was deviated posteriorly and to the left. Thyroidectomy was followed by normal convalescence and the patient was discharged on the seventh postoperative day. The lobes of the gland weighed 136 grams and 40 grams. There were numerous discrete rubbery nodules on the surface. The cut surface was pale. Numerous colloid ascini were seen and there were numerous dark hemorrhagic areas. On microscopic examination, the thyroid tissue was largely replaced by massive infiltration with plasma cells. Twenty-seven months later, the patient's condition remained good without evidence of recurrence.

After review of the various theories regarding the histogenesis of the condition, the authors state that, in their opinion, the condition represents a true neoplasm rather than a type or stage of thyroiditis.

R. H. S.

ANNOUNCEMENTS

NOTICE

The Florida Assembly of The Southeastern Surgical Congress will be held at the Hollywood Beach Hotel, Hollywood, Florida, April 11-14, 1951.

For hotel reservations, write to the manager of the hotel.

For other information, write to the secretary, Dr. B. T. Beasley, 701 Hurt Building, Atlanta, Ga.

ANNOUNCEMENT OF VAN METER PRIZE AWARD

The American Goiter Association again offers the Van Meter Prize Award of Three Hundred Dollars and two honorable mentions for the best essays submitted concerning original work on problems related to the thyroid gland. The Award will be made at the annual meeting of the Association which will be held in Columbus, Ohio, May 24, 25 and 26, 1951, providing essays of sufficient merit are presented in competition.

The competing essays may cover either clinical or research investigations; should not exceed three thousand words in length; must be presented in English; and a typewritten double spaced copy in duplicate sent to the Corresponding Secretary, Dr. George C. Shivers, 100 East Saint Vrain Street, Colorado Springs, Colorado, not later than March 1, 1951. The committee who will review the manuscripts is composed of men well qualified to judge the merits of the competing essays.

A place will be reserved on the program of the annual meeting for presentation of the Prize Award Essay by the author, if it is possible for him to attend. The essay will be published in the annual Proceedings of the Association.

ANNOUNCEMENT

The annual meeting of the Southeastern States Cancer Seminar will be held in Jacksonville, Florida, 8, 9, and 10, November, 1950, at the George Washington Hotel auditorium. A well rounded program has been planned which will be of interest to every branch of medicine.